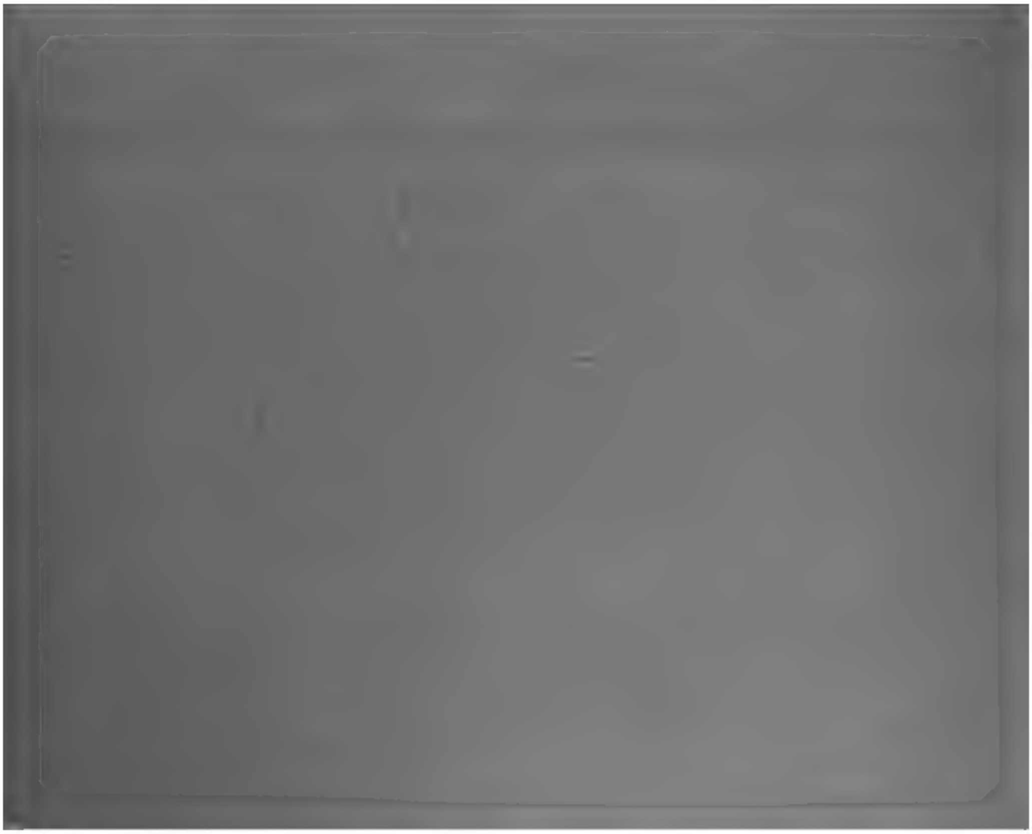

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TWENTY-EIGHTH ANNUAL REPORT

OF THE

STATE BOARD OF HEALTH

OF

MASSACHUSETTS.

[redacted]

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1896–1897.

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Typhoid Fever.

No disease or cause of death constitutes a better index or measure of the efficiency of sanitary work than typhoid fever. The number of deaths from this disease has diminished with considerable uniformity in proportion as public water supplies have been introduced in the cities and towns. A table and diagram in the portion of this report which is specially devoted to vital statistics illustrates this principle.

The returns for 1896 are not all in at the date of writing this, but sufficient information is at hand to show that the past year proves no exception to the rule. The notifications of infectious diseases which are constantly received at the office of the Board give evidence of the fact as well as the diminished requests for the assistance of the Board in the investigation of epidemics.

The principal epidemic of this character which occurred during the time embraced in this report was that of North Adams. This epidemic was reported to the State Board of Health by the board of health of North Adams late in September, 1895, and Professor Sedgwick was instructed to proceed to North Adams and to investigate the cause and aid the local board in its inquiries.

It appears from the table which is given on page xiv that North Adams has had a persistently high death-rate from typhoid fever for several years.

Professor Sedgwick found that considerable apprehension existed at North Adams with reference to the condition of the water supply, which is taken from certain reservoirs made by impounding the water of brooks in comparatively uninhabited regions, and from driven wells near the centre of the city.

Although the water of these wells is hard and comparatively impure it did not appear that they could be charged with causing the unusual prevalence of typhoid fever, since the distribution of the cases would not warrant this inference. Most of the cases in 1895 occurred in the western and northern sections of the city and especially in the valley along the watershed of the north branch of the Hoosac River.

The deaths registered in the four months of June, July, August and September in the five years 1891–95 were as follows: 1891, 3, 1892, 3, 1893, 5, 1894, 10 and 1895, 11.

The cases which occurred in 1895 did not appear simultaneously or in large numbers, as is common in epidemics due to infected milk

or infected water supplies, but were continued at intervals from the middle of July to October, a few being reported in each week.

Professor Sedgwick says: "The epidemic was of a slow, insidious character, as if slowly passing from person to person, and from house to house; and as has been stated, it was confined to one, and that an unsanitary section of the city."

It was recommended that an agent of the Board of Health should be detailed to give special attention to disinfection among the houses in this district where the fever existed.

Limited outbreaks were also reported as having occurred at the Mount Hermon School in Northfield, at the State Prison, and at Rowley, Mass., but the total number of such outbreaks has been much less than it has in previous years.

Five men were taken ill at the State Prison in October, and the secretary visited the prison and inspected its sanitary condition. The general condition of the buildings, cells, kitchen, hospital and other apartments appeared to be good. A sewer was being constructed in the grounds outside, upon which the convicts were at work, but none of those who were taken ill had worked upon this sewer.

The water supply is the water of Mystic Lake in Medford, occasionally alternating with water from the general, or Cochituate and Sudbury supply. The Mystic supplies the cities of Somerville, Everett and Chelsea. An inquiry of the health authorities of these cities showed that typhoid fever was not unusually prevalent among them at the time of the occurrence of the cases at the prison.

Attention was then turned to the milk supply, which was obtained from a contractor doing business in Charlestown, having a large business, and obtaining his milk from about one thousand dairies in Maine and southern New Hampshire. The milk came in each morning over the Western Division of the Boston & Maine Railroad, being collected at a station in southern New Hampshire.

The conditions prevailing at the milk distributing station at Charlestown were fairly good, and all the men connected with the work of distribution and present at the station appeared to be in good health and free from infection.

One man who had charge of the stable, opening out of the distributing room, was given a vacation September 8 and went away, but was soon after attacked with typhoid fever and went to hospital, where he was at the time of the inspection (October 22). This man

had no connection with the work of distributing or handling of the milk, and his illness was undoubtedly in the relation of effect and not of cause, since he and his family used the milk furnished by this contractor.

The supply furnished to the prison was forty cans four times a week, and these were not always from the same dairies, but so far as could be learned were from several dairies along the line of a railway extending from southern New Hampshire to Maine. It was deemed impracticable to continue the investigation in this direction.

Another limited epidemic, in which the total number of cases was only 7, was that of the Mount Hermon School, on the west bank of the Connecticut River in Northfield. An inspection of the school was made and advice given relative to its water supply and sewage disposal.

In the reports of the Board from 1890 to 1895, inclusive, a table has been published annually presenting the deaths and death-rates from typhoid fever for a series of years in the cities of the State, these cities being arranged in the order of their population. In the present report, page xiv, this table has been rearranged, the statistics relating to typhoid fever being presented in five-year groups, and in each period the cities are arranged in accordance with the intensity of their death-rates from typhoid fever. North Adams, which became a city in 1895, has been added to the list, making a total of thirty-two cities.

By means of this table the comparative rank of the different cities in each period and the rise or fall in the typhoid death-rate from one period to another are shown.

While the general improvement in the death-rate from typhoid fever, coincident with the introduction of better water supplies, is shown in the latter part of the report in the portion relating to vital statistics, it also appears in this table, where the conditions of certain cities are considered separately.

In some instances radical changes have taken place in the rank of cities, comparing early with late periods. Boston has maintained a position quite uniformly intermediate in the list, and usually slightly below that of the State. It would undoubtedly have been still lower were it not for its intimate connection with the surrounding territory and the presence of many hospitals, in which patients from other cities and towns are admitted for treatment. The manufacturing cities, Holyoke, Springfield, Chicopee, Lowell, Lawrence, Fall River and North Adams, have generally had high death-rates

throughout most of the time included in the table. On the other hand, the smaller residential cities, Waltham, Newton, Medford, Everett and Woburn, have usually been found near the foot of the list, with low typhoid death-rates.

Holyoke, which in the first three five-year periods was at the head of the list of high death-rates, has shown a decided improvement in the fourth and fifth periods.

Pittsfield, also, from a position above the mean, has dropped below the mean, and in the fifth period had the lowest death-rate from typhoid fever among the cities.

On the other hand, Newburyport has changed its position from a generally low rank to a position near the top of the list.

The death-rates in this table are annual death-rates per 10,000 of the living population. The population had increased, during the whole period indicated in the table, about 83 per cent. (comparing the mean population of the first five years with that of the last five).

Deaths and Death-rates per 10,000 Inhabitants from Typhoid Fever in Massachusetts Cities, 1871-95.

	1871-1875.			1876-1880.			1881-1885.			1886-1890.			1891-1895.	
Holyoke,	157	23.3	Holyoke,	77	8.1	Holyoke,	159	12.8	Lowell,	396	11.2	North Adams,	74	8.4
Springfield,	214	14.8	Lawrence,	122	6.6	Chicopee,	48	8.4	Lawrence,	233	11.2	Lawrence,	187	7.7
Chicopee,	63	12.6	Chicopee,	35	6.5	Lowell,	243	7.9	North Adams,	64	8.9	Lowell,	294	7.3
Lawrence,	190	11.9	Fall River,	162	6.4	North Adams,	43	7.6	Chicopee,	43	6.7	Chicopee,	50	6.6
Lowell,	221	9.8	Malden,	31	5.4	Lawrence,	144	7.4	Fall River,	209	6.4	Woburn,	33	4.8
Fall River,	175	9.8	Springfield,	86	5.3	Fall River,	174	6.6	Holyoke,	105	6.6	Newburyport,	29	4.1
Pittsfield,	56	9.6	Worcester,	131	4.9	Springfield,	117	6.6	Marlborough,	32	5.2	Springfield,	97	4.1
Brockton,	43	9.2	Haverhill,	40	4.8	Taunton,	59	5.8	Quincy,	37	5.1	Quincy,	37	4.0
Chelsea,	86	8.7	Salem,	61	4.6	Lynn,	109	5.2	Pittsfield,	40	5.0	Salem,	63	3.9
Northampton,	46	8.7	Newburyport,	31	4.6	Haverhill,	52	5.2	Haverhill,	50	4.8	Fall River,	154	3.8
New Bedford,	99	8.4	Pittsfield,	29	4.5	Boston,	952	5.1	Taunton,	58	4.7	Holyoke,	72	3.8
Worcester,	176	7.8	Lowell,	117	4.3	Pittsfield,	34	4.9	Springfield,	88	4.3	Haverhill,	49	3.4
Lynn,	118	7.8	Quincy,	21	4.3	Brockton,	41	4.8	Salem,	59	4.0	Marlborough,	24	3.3
Boston,	1,145	7.7	Marlborough,	20	4.3	Quincy,	27	4.5	Newton,	44	4.0	New Bedford,	77	3.2
Somerville,	69	7.6	North Adams,*	16	4.3	Salem,	66	4.7	Boston,	818	3.9	Boston,	722	3.1
Salem,	87	6.9	Lynn,	72	4.1	Northampton,	29	4.5	New Bedford,	71	3.8	Somerville,	65	2.8
Taunton,	65	6.7	Boston,	690	3.9	New Bedford,	62	4.1	Brockton,	46	3.8	Brockton,	41	2.7
Haverhill,	46	6.6	New Bedford,	50	3.8	Marlborough,	20	3.8	Woburn,	24	3.8	Malden,	56	2.7
Marlborough,	27	6.4	Gloucester,	34	3.8	Cambridge,	103	3.7	Cambridge,	116	3.6	Medford,	17	2.7
Gloucester,	51	6.3	Chelsea,	36	3.4	Gloucester,	36	3.7	Malden,	33	3.3	Worcester,	120	2.6
Cambridge,	124	5.7	Medford,	12	3.4	Everett,	9	3.6	Fitchburg,	31	3.3	Cambridge,	91	2.4
Woburn,	26	5.7	Taunton,	34	3.3	Newton,	31	3.4	Everett,	14	3.3	Chelsea,	35	2.4
Malden,	25	5.5	Northampton,	19	3.3	Worcester,	106	3.3	Northampton,	22	3.2	Everett,	18	2.4
Fitchburg,	32	5.4	Beverly,	13	3.3	Somerville,	46	3.3	Worcester,	109	2.8	Lynn,	64	2.2
Beverly,	18	5.2	Newton,	25	3.0	Newburyport,	22	3.2	Somerville,	40	2.8	Taunton,	29	2.2
Quincy,	19	4.6	Somerville,	33	2.8	Chelsea,	37	3.1	Chelsea,	35	2.6	Newton,	28	2.2
Newburyport,	29	4.5	Fitchburg,	17	2.5	Malden,	21	3.0	Newburyport,	17	2.5	Northampton,	17	2.1
Everett,	6	4.1	Brockton,	14	2.3	Waltham,	20	3.0	Lynn,	56	2.2	Beverly,	11	1.9
Medford,	11	3.6	Cambridge,	55	2.2	Fitchburg,	18	2.6	Gloucester,	25	2.2	Fitchburg,	22	1.8
Newton,	20	2.6	Woburn,	10	2.0	Medford,	11	2.6	Medford,	11	2.2	Waltham,	18	1.8
Waltham,	13	2.7	Waltham,	8	1.5	Woburn,	14	2.5	Waltham,	17	2.0	Gloucester,	19	1.4
			Everett,	2	1.0	Beverly,	10	2.3	Beverly,	10	2.0	Pittsfield,	25	1.3
Total,	3,458	-		2,093	-		2,864	-		2,971	-		2,618	-
Means for the cities,	-	8.2		-	4.2		-	5.1		-	4.6		-	3.4
THE STATE,	-	8.2		-	4.5		-	5.0		-	4.1		-	3.2

* North Adams not incorporated till 1878.

This comparison may be carried still further by an examination of the following table for the year 1896, which has been made up from the returns required by chapter 218 of the Acts of 1894. The figures in this table may differ slightly from those which are obtained from the Registration Report at a later date, but the difference is usually very small. It may also be noted that the results of a single year are not so conclusive as those of longer periods, and those of small cities are less conclusive than those of large ones, according to the usual principle of the *limits of error*.

Deaths from Typhoid Fever (1896).

	Deaths.	Deaths per 10,000 Living.		Deaths.	Deaths per 10,000 Living.
Haverhill,	18	5.84	Taunton,	6	2.18
North Adams,	11	5.57	Springfield,	11	2.07
Newburyport,	8	5.45	Medford,	3	1.98
Somerville,	26	4.73	Marlborough,	3	1.97
Pittsfield,	10	4.72	Malden,	6	1.92
Lynn,	27	4.23	Waltham,	4	1.87
Lowell,	36	4.20	Lawrence,	10	1.86
Quincy,	9	4.16	Brockton,	6	1.74
Cambridge,	30	3.56	Chelsea,	5	1.56
Chicopee,	6	3.55	Fitchburg,	4	1.46
Beverly,	4	3.33	Worcester,	14	1.37
Boston,	162	3.19	Salem,	4	1.13
Gloucester,	9	3.10	Holyoke,	4	0.97
Everett,	6	2.91	Northampton,	1	0.58
Fall River,	25	2.70	Woburn,	0	0.00
Newton,	7	2.47	Total,	489	-
New Bedford,	14	2.38	Mean,	-	2.90

Haverhill is found at the top of the list in this table for 1896. With regard to the high typhoid death-rate of Haverhill in 1896 reference may be made to Professor Sedgwick's report to the board of health of that city, quoted near the close of this volume, under the head of "Health of Towns."

Lynn in the last decade, 1886–95, maintained a record for typhoid fever mortality better than the average. In 1896 the death-rate of Lynn from typhoid fever is only the sixth from the top of the list.

On the other hand, Lawrence, which for twenty years used the polluted water of the Merrimack River without filtration, had during that period an invariably high typhoid mortality. Since the introduction of thorough filtration, at the advice of the State Board, its rank in the columns of this table has fallen to a position quite near the bottom of the list, and a mortality of only 1.86 per 10,000 in 1896.

Holyoke has a comparatively good public water supply, but for the first three five-year periods stood at the top of the list, with the highest typhoid mortality. It then fell to the sixth place in the fourth and the eleventh place in the fifth period, and then to the thirtieth in the year 1896. Upon investigation by the State Board of Health in 1891 it was found that, notwithstanding the good quality of its water supply, much water was taken for drinking purposes from the three canals, either directly or but imperfectly filtered by means of defective filtering galleries in the bottom of the canals. The authorities were advised to discontinue this practice.

It may be added as a general statement, in regard to these tables, that the mean typhoid death-rate of the cities in the first or upper half of the list in 1896 is less than the mean typhoid death-rate of the cities in the lower half in the period 1871–75, and that some cities which have maintained a comparatively uniform rate through the whole time from 1871 to 1896 have apparently risen in this table to a higher relative position, for the reason that this very marked improvement has taken place in many other cities.

In 1896, for the first time, there are three cities having a combined population of over 70,000 in which the typhoid death-rate was less than 1 per 10,000, and in one of them (Woburn) there were no deaths from this cause.

Consumption.

In the last annual report of the Board a copy of the circular issued by the Board in the preceding year was published. Soon after the publication of the circular, the attention of the Board was called to a monograph by Dr. J. B. Russell, the Senior Medical Officer of Health of Glasgow, which had recently been published in that city, entitled "The Prevention of Tuberculosis."

The practical tone of the book, and its clear and intelligent presentation of the subject, led the Board to reprint it for distribution in Massachusetts, with the consent of the author. An edition of five

thousand was published and distributed throughout the State. No publication of the Board has been received and read with greater interest, and it is hoped that much benefit will be derived from its free circulation. Copies may be had on application to the Board.

Diphtheria.

No disease or cause of death has received greater attention in recent years than diphtheria, and it is hoped that the vigorous action of health authorities now being conducted against this disease will be followed by similar results as appear to be taking place in the death-rate from tuberculosis. The efforts at prevention and restriction of disease now going on in all civilized countries may well receive the title usually given to them in German cities, "a campaign against infection."

In the interest of the health of the people the Board has therefore believed it proper to offer every possible facility to the different municipalities both for the diagnosis and for the preventive treatment of diphtheria.

For the first of these objects, the diagnosis of diphtheria, a system of examination of throat cultures has been established, whereby such cultures may be forwarded to the Board for examination from any city or town in the State, sets of tubes containing the culture material being deposited with boards of health and druggists in convenient locations. An account of the first year's work in this direction may be found in this report.

For the second object, the furnishing of antitoxine, the methods adopted by the Board have already been described in the report of last year, and a continuation of the subject is presented in this report.

Malarial Fever.

In 1885 malarial fever appeared for the first time as a serious epidemic in eastern Massachusetts at South Framingham, and was made the subject of a report by Dr. Z. B. Adams in the seventh annual report of the Board of Health, Lunacy and Charity, Supplement on Public Health.

From that time it appeared successively in other towns in the eastern part of the State, and reports have been made upon its operations by different writers.

The reports which have been published by the State Board of Health are as follows: —

Report of 1880, by Dr. J. F. A. Adams of Pittsfield.
Report of 1885, by Dr. Z. B. Adams of Framingham.
Report of 1889, by Dr. C. H. Cook of Natick.
Brief statement in report of 1888 of its prevalence in Deerfield.

In addition to these, special examinations have been made of the territory along the banks of the Charles River from Dedham to tidewater. This examination was made by the Board, acting conjointly with the Metropolitan Park Commission, first of the region from Waltham to the sea, and secondly, of the region immediately above Waltham.

Investigations have also been made at Uxbridge, North Saugus and at Woburn, in each of which places there have been serious outbreaks of malarial fever. In a small district in Woburn, mostly upon the shores and territory contiguous to Horn Pond, a house-to-house inquiry revealed the fact that over 1,900 cases of malarial disease had existed in this district during the years 1894, 1895 and 1896 in a somewhat densely settled district covering an area of about one-half square mile.

Offensive Trades.

No complaints were made directly to the Board during the year with regard to offensive trades, and consequently no hearings upon the subject were held. In consequence of the more efficient organization of local boards of health in the cities and large towns such matters have in the past two years been settled by the local boards.

In one instance the advice of the Board was asked as to the mode of dealing with a nuisance of this character located in the town of Mansfield, where an establishment existed for the purpose of conducting the business of making fertilizers in a very crude manner, the carcasses of animals being treated with acids out-of-doors and then covered with a light coating of soil, the effect being to produce a very foul odor in the neighborhood.

Manual of Health Laws.

The Board has published at intervals of about four years, since 1882, an edition of the health laws of the State, each edition containing the health statutes in force up to the time of its publication.

An edition was published in 1894 which soon became exhausted, although a larger edition was printed than usual.

In 1896 a new edition was prepared, and was revised with unusual care by E. M. Parker, Esq., of Cambridge, the health laws in force up to January, 1897, being included. A new feature of the manual is the complete index of all the laws in force which precedes the text, each law being referred to by chapter and page of the manual. A very complete index is added at the end of the book.

As an aid to local health boards, physicians and court officers it will be found indispensable. The following partial list of its contents conveys an idea of its comprehensive character: general powers and duties of the State Board of Health, local boards, nuisances, infectious diseases, vaccination, protection of infants, quarantine, offensive trades, water supply and sewerage, public baths, cemeteries and burials, cremation, cattle diseases, medical societies, color blindness, instruction in physiology, etc., sanitary work of district police, plumbing, stables, bakeries, food and drug inspection, registration of vital statistics, inquests.

Lead Poisoning.

This subject was mentioned in the last report of the Board, with special reference to the occurrence of an unusual number of cases of illness in the town of Kingston, which upon investigation by the Board was shown conclusively to have been caused by the presence of lead in the water of the public water supply, and which could only be accounted for by the free use of lead for service pipes in the town. The Board at that time, Sept. 23, 1895, wrote to the water board of Kingston, recommending the "immediate removal of all lead pipes in the town, wherever they are used for conveying water for domestic use, either as service pipes or as street mains."

Since that time other cases of similar character have been reported from other parts of the State, notably from Fairhaven, New Bedford and Milford, and further investigations are being conducted with reference to the action of the public water supplies upon lead pipe. The results of these investigations will be made known in a future report.

Inspection of Summer Resorts.

There has been for many years a limited number of places, at different points in the State, at which large numbers of people congregate during the summer months for longer or shorter periods of time. These were in some instances owned and controlled by relig-

ious or other organizations. They were usually located either on the seashore or upon the banks of a river or lake or pond. At some places cottages were built and quite a summer village was maintained, as in the case of Cottage City, Onset Bay, Brant Rock, Salisbury Beach, Pleasant Lake in Franklin County, etc. In other cases the camp or picnic ground was of a more temporary character, where people gathered in large numbers for a single day. The latter class of resorts has very greatly multiplied within the past ten years, their rapid increase being due largely to the development of electric railways in the neighborhood of the populous towns, and the desire of such corporations to provide amusement for their patrons.

In one instance, eight such resorts of different size and character have been established upon the shores of a single lake or pond, three upon another lake, and so on, and in some instances such places have been located upon the watersheds of public water supplies. In the case already noted, where eight places of this character exist upon one lake or pond, the water of the pond is the water of the public supply of the neighboring town. It is, however, filtered through the gravel and drawn from wells or galleries upon the shore of the lake.

It was, therefore, decided by the Board that an investigation of the sanitary condition of these places should be made, with several points in view, and with the intention of advising or recommending such changes as were deemed necessary to remedy defects and to improve existing unsanitary conditions. The special points which were kept in mind in the investigation were: *First*, the possibility of such places proving dangerous to public water supplies, in consequence of their location upon the watersheds. *Second*, as to the water supplies furnished to the patrons of these resorts. *Third*, the drainage and sewerage of the buildings. *Fourth*, their general sanitary condition, and especially that of the restaurants, kitchens, water-closets and the disposal of the garbage and other waste matters.

The investigation was under the management of Prof. W. T. Sedgwick and a corps of inspectors, and many places were also visited by the secretary.

The whole number of such places which existed in the State so far as was known at the time of the inspection was 130, and nearly all of these were visited personally and during the season of patronage.

Reports were made to the Board upon their sanitary condition, and letters were then issued to the proprietors of those resorts where existing conditions were unsatisfactory, describing the nature of the conditions which needed improvement, and in such instances as were necessary the aid of the Board was offered in examining and approving such plans as might be devised for the remedy of unsanitary conditions. In most instances the proprietors cheerfully complied with such suggestions as were made.

The distribution of these resorts by counties was as follows: —

In Barnstable County,	1	In Hampshire County,	3
In Berkshire County,	4	In Middlesex County,	19
In Bristol County,	11	In Nantucket County,	1
In Dukes County,	6	In Norfolk County,	12
In Essex County,	11	In Plymouth County,	5
In Franklin County,	4	In Suffolk County,	1
In Hampden County,	11	In Worcester County,	41

Water Supply and Sewerage.

When the State Board of Health was reorganized in 1886, upon a similar plan to that of the original board of 1869, a new law was enacted which gave to the Board enlarged powers and new duties of the highest importance, having special reference to the water supplies and systems of sewerage which constitute so large a share of the public sanitary works throughout the State. This law, entitled the "act to protect the purity of inland waters," often alluded to in these reports, has proved one of the most useful and comprehensive enactments of recent years. Under its provisions an engineering department was established, which has carried out all the important work of this character which has been accomplished by the Board during the succeeding years.

Among the transactions of this department of work, already noticed in the reports of the Board, may be enumerated the establishment of the experiment station at Lawrence, with the many important additions to science which have been made there; the maintenance of a laboratory in Boston for constant use in the examination of the waters of the State, with equally important discoveries and demonstrations of new principles in this department of work (*e. g.*, the chlorine determinations of the waters of different localities at variable distances from the sea and their practical usefulness); the constant general supervision of water supplies and systems of

sewerage; the continuous examinations of these waters by means of chemical and bacterial analyses, as well as personal inspection of the sources of supply, especially of those of doubtful quality; the work of giving advice to cities, towns, corporations and individuals as to the selection of new sources of supply, the improvement and enlargement of old ones, the introduction of systems of sewerage and sewage disposal.

In addition to all these duties, the establishment of this department has made it possible for the Board to carry out the wishes of the Legislature in regard to the following matters, some of which may be reckoned among the most important public undertakings in the State: the devising of the metropolitan sewerage system, now being completed, started in 1889; the investigation of the sources of ice supply of the State (1890) and of manufactured ice (1893); the metropolitan water supply (1895), now in process of construction; the improvement of the Charles River, two reports (1894 and 1896); the improvement of the Concord and Sudbury rivers (the work of making these improvements was intrusted to the Board); improvement of the Neponset River; the sewerage of Salem and Peabody; and the investigation of the Green Harbor dike and marshes.

In the present report the details of the work performed by this department in carrying out its routine duties will be found under the head of "Advice to Towns;" "Examination of Water Supplies and Rivers;" "Summary of Water Supply Statistics;" "Work at the Lawrence Experiment Station in 1896;" and "Sewage Purification of Cities and Towns in Massachusetts."

Bacteriological Department for Investigations relative to the Prevalence of Infectious Diseases.

This department of the work of the Board was established at the Bussey Institute, near the Forest Hills station of the New York, New Haven & Hartford Railroad, in 1894, and at once became a most important adjunct to the work of the Board. Dr. Theobald Smith, Fabyan Professor of Comparative Pathology at Harvard University, has charge of the work of the laboratory, which now consists mainly of the diagnostic examination of suspected diphtheria cultures, of material forwarded to the Board to be examined for the presence of tubercle bacilli, of specimens from the blood of persons suffering with malarial symptoms, the preparation of diphtheria

antitoxin, and such investigations of an experimental character as are from time to time deemed necessary. In addition to the supply of diphtheria serum, a supply of tetanus antitoxin is also now prepared for such use as may be demanded.

Very much of this work is conducted under the difficulties incident to constant transmission of material by express and messenger service, and of daily correspondence with local boards and physicians by means of the mails, telegraphs and telephones.

Cities and towns in all parts of the State, including several in Berkshire County, at a distance of one hundred and fifty miles from the laboratory, have availed themselves of the advantages of this department.

This useful work has grown rapidly, and at the present time several of the local boards of health of large cities have organized departments of their own for the purpose of bacteriological examination. In one instance (in the city of Boston) the local board also maintains a plant for the production of antitoxin.

Some of the important operations of this department of the Board's work may be found detailed in this volume under the head of reports upon "Toxin Production," "Antitoxin" and "Malaria."

Vital Statistics of the State.

It has been customary in recent years to publish in the annual report of the Board a condensed statement of the vital statistics of the State, since all correct deductions relating to the sanitary progress of a community must depend for their accuracy upon the records to be found in the returns of the vital statistics of cities and towns. In the present report special attention has been given to this subject by the presentation of a summary embracing the statistics of forty years, and including the period from 1856 to 1895, inclusive.

Improvement of the Charles River.

By the provisions of chapter 475 of the Acts of 1893 the Board together with the Metropolitan Park Commissioners were made a joint board to investigate the "sanitary condition and prepare plans for the improvement of the beds, shores and waters of the Charles River, between Charles River bridge and the Waltham line on Charles River, and for the removal of any nuisances therefrom."

The report of this joint board was made to the Legislature in April, 1894, and was also published in the twenty-sixth annual report of the Board (page cxxxiii).

An act was passed in that year (1894) by which the joint board was continued and instructed to investigate the condition of the river from the point at which the previous investigation terminated as far as Mother Brook in Dedham, and to "report plans for its improvement and for the removal of nuisances therefrom."

This report was completed and submitted to the Legislature in May, 1896, and the general report of the joint board is published in this volume. The original report also contains a summary of the prevalence of intermittent fever in the region embraced in the report, by Dr. J. J. Thomas, who collected information relative to the occurrence of nearly five thousand cases of malarial disease in this region in the period 1890–94.

The Sewerage of Salem and Peabody.

The city of Salem and the town of Peabody are two municipalities, the former lying upon Salem harbor and the latter adjoining Salem, but further inland. They have a combined population of nearly 45,000, and are without an adequate system of sewerage. The sewage of the city is discharged without system, along the shores, while that of Peabody, consisting largely of the drainage of tanneries, empties into the North River, which flows into Salem harbor at the northern boundary of the city and also receives sewage from Salem.

By the provisions of chapter 112 of the Resolves of 1895 the State Board of Health was "authorized and directed to consider and report a general system of drainage and sewerage" for Salem and Peabody, or "for such parts of said city and town, not all of which shall be wholly within either of said municipalities, as may, in the opinion of said Board, be best drained by said system."

By the terms of this resolve this report was to have been made in January, 1896, but the time was insufficient for the required survey, and was therefore extended by the provisions of chapter 69 of the Resolves of 1896 to January, 1897.

The general report of the Board upon this subject will be found in the present volume.

The Neponset Meadows.

In the last annual report of the Board (1895) reference was made to the action of the General Court directing the State Board of Health to "investigate the sanitary condition of the meadows of the

Neponset River, and the bed, shores and waters of said river in the towns of Canton, Sharon, Norwood, Dedham, Milton and Hyde Park, and report whether their condition is dangerous or injurious to the public health by reason of stagnant water, or refuse from manufactories, or other causes" (chapter 83, Resolves of 1895).

The investigations required by this resolve were completed and the report was made to the Legislature in May, 1897.

The general report is also published in this volume. The recommendations of the Board were as follows: —

1. Legislation to prevent the pollution of the river.
2. Removal of the flash boards at the dam at Mattapan, enlargement of cross-section of the river at certain points, and deepening and reconstruction of the channel wherever it is necessary to prevent flooding of the meadows.

Green Harbor River.

In the report of the Board for 1894 reference is made to a petition of those inhabitants of Marshfield living at Green Harbor, a settlement upon the seashore in the easterly part of that town. By the provisions of chapter 303 of the Acts of 1871 a dike was built across the outlet of this river about a half mile above its mouth, by which some two or three miles of salt marsh were converted into a fresh-water region.

Application was made to the Legislature for the removal of the dike. The question was referred to the State Board of Health and the Harbor and Land Commissioners in 1896, acting as a joint board, to investigate and report upon the matter. This investigation is now in progress.

Local Boards of Health.

As towns increase in population, and consequently in the density with which the principal villages are settled, the need of efficient sanitary supervision becomes more apparent every year. Boards of health are organized in towns where no separate board has previously existed. Legislation is also being enacted every year, giving additional powers to boards of health and increasing their duties.

Among the duties imposed upon local boards in more recent years are those which relate to cattle diseases, the inspection of plumbing, the licensing of stables, the inspection of bakeries, the reporting of cases of infectious diseases and of annual mortality returns to the State Board of Health.

A question of considerable importance which has arisen in two different towns during the past year is the relation of local boards of health to such public institutions as exist in the different cities and towns.

Several circumstances in recent years have tended to bring the State and local boards of health into closer mutual relations to each other. (1) The enactment of statutes requiring annual returns of deaths to the State Board by local boards, and the immediate reporting of all infectious diseases by local boards. (2) The work undertaken by the State Board to assist local boards in the diagnosis of infectious diseases, and in the supply of antitoxin for the treatment of diphtheria. (3) The general supervision of water supplies and systems of sewerage, which was required of the State Board in 1886.

Reference has already been made in previous reports of the Board to the organization of the Association of Boards of Health, at whose quarterly meetings the representatives of the State and local boards meet for the discussion of all questions which pertain to municipal as well as to general hygiene. This organization has proved very helpful to those local boards which have availed themselves of its privileges.

The efficiency of the sanitary supervision of cities and towns may be in some measure shown by the vital statistics of the State for the past thirty years. It is one of the first principles of general hygiene that the death-rate increases with the density of population, other things being equal.

Hygienic conditions, however, may be so greatly improved as to offset the harmful effects of increasing density. During the past thirty years the population of Massachusetts has doubled in number, and the density has increased in like proportion (that of 1865 was 152 inhabitants per square mile, and that of 1895, 300); yet the death-rate has remained about the same throughout these thirty years, when long periods of time are considered and not single years.

The death-rates of the population of the three successive decades since 1865 were as follows: —

Periods.	Death-rate.
1866-75,	19.59
1876-85,	19.35
1886-95,	19.63

These figures, when considered in connection with the doubling of *the density,* may be taken as an index of decidedly improved sanitary *conditions.*

Health of Towns.

A digest of the principal facts of importance published in the annual reports of local boards of health occupies the final pages of this report. The general character of these reports indicates a decided improvement in the work of local boards, especially in the direction of the management and control of infectious diseases.

The table containing the number of cases and deaths from certain infectious diseases with the ratio of fatality which was formerly published in connection with this digest has been transferred from this portion of the report to that part which is entitled "Statistical Summaries of Disease and Mortality."

Routine Work of the Board.

During the year ending Sept. 30, 1896, the Board held meetings at least once in each month. Meetings of such of the standing committees as were necessary for the transaction of business were also held from time to time, as well as joint sessions with such other boards or commissions as were prescribed by the Legislature.

The office of the Board has been open throughout the year, as prescribed by the Public Statutes, chapter 21, section 10,* for the transaction of its authorized business.

Advice has been very frequently given at the office and by mail to local boards and to individuals in regard to sanitary matters, and many visits have been made by the secretary, the engineers and other experts to cities and towns for the purpose of making investigations and giving advice.

The work of the office has become materially increased in consequence of being made a central station for the distribution of anti-toxin to local boards of health, hospitals and physicians in private practice. To this has been added during the past year the work of examining the products of certain infectious diseases for the purpose of determining their character, notably diphtheria, tuberculosis and malarial fever.

The statistics of mortality compiled from the weekly postal card returns from the registering authorities of cities and towns have been published weekly during the year in the form of a bulletin, which also contains, once in each month, a report of the work done in the

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* Office hours, 9 A.M. *to* 5 P.M.; *Saturdays*, 9 A.M. to 2 P.M.

line of food and drug inspection, together with the prosecutions made under the food and drug acts, and other important information relative to the work of this department. In addition to these items there is also published in the same bulletin a weekly report of the number of cases of infectious diseases reported by the local boards to the State Board of Health.

The following table presents certain statistical data relative to the routine work of the Board: —

STATISTICAL TABLE FOR THE YEAR ENDING SEPT. 30, 1896.

Whole number of samples of foods and drugs examined during the year,	8,338
Samples of milk examined (included in the foregoing),	4,484
Whole number examined since beginning of work in 1883,	76,113
Whole number of samples of milk examined since beginning of work in 1883,	38,905
Number of prosecutions against offenders during the year,	75
Number of convictions during the year,	74
Amount of fines secured during the year,	$2,812 20
Number of packages of antitoxin issued to cities and towns,*	3,245
Number of bacterial cultures made for the diagnosis of diphtheria in cities and towns,*	1,469
Number of examinations made for diagnosis of tuberculosis,*	124
Number of examinations of blood made for diagnosis of malarial infection,*	57
Number of notices of cases of infectious diseases received and recorded under the provisions of chapter 302, Acts of 1893,†	21,315
Number of postal card returns of mortality for cities and towns received and recorded,†	2,340
Number of annual reports of cities and towns received under the provisions ‡ of Acts of 1894, chapter 218,†	86

Force employed in general work of Board at central office, State House: —		
Secretary,		1
Clerks,		2
Messenger,		1
Total,		4
Force employed at central office, State House, Boston, for food and drug inspection, chemists and assistants,	2	
At Amherst,	1	
		3
Inspectors,		3
Total,		6

* For the year ending March 31, 1897. † For the calendar year 1896.
‡ Towns having a population of over 5,000 inhabitants in each.

Force employed at laboratory (Bussey Institute): —

Pathologist,	1
Assistants,	3
	4

UNDER THE PROVISIONS OF CHAPTER 375, ACTS OF 1888.

Applications for advice from cities, towns and others: —

Relating to water supply,	39
Relating to sewerage and drainage,	19
Relating to pollution of streams,	7
Total,	65

Number of samples of water examined chemically and microscopically at the Massachusetts Institute of Technology,	2,200
Number of samples of sewage and effluent from sewage purification works examined chemically at the Massachusetts Institute of Technology,	199
Number of samples of sewage and water examined chemically and bacterially at the Lawrence Experiment Station,	2,929
Number of samples of sand examined chemically and bacterially at the Lawrence Experiment Station,	211
Number of samples of sand examined mechanically at the Lawrence Experiment Station,	115
Additional samples examined bacterially at the Lawrence Experiment Station,	6,500
Total number of samples examined,	12,154

Force employed at central office:* —		
Chief engineer,	1	
Assistant engineers,	3	
Stenographers and clerks,	2	
		6
At Massachusetts Institute of Technology: —		
Chemists,	5	
Chief biologist,	1	
Assistant biologist,	1	
		7
At Lawrence Experiment Station: —		
Chemists,	3	
Bacteriologists,	2	
Other assistants and laborers,	4	
		9
Total ordinary force employed under chapter 375, Acts of 1888,		22
Total ordinary force in all departments,		36

* Not including the force employed upon the improvement of Charles, Concord, Sudbury and Neponset rivers, Salem and Peabody sewerage, or Marshfield investigation.

The number of applications for advice under the provisions of chapter 375, Acts of 1888, received since July, 1886, when the act relating to water supply and sewerage first went into operation, is as follows: —

1886,	8	1893,	51
1887,	22	1894,	53
1888,	28	1895,	52
1889,	38	1896,	65
1890,	23		
1891,	53	Total,	449
1892,	56		

Recommendations.

The following recommendation was made to the Legislature at the beginning of the session of 1897: —

The Board recommends the continuance of its investigations now being carried on as authorized by the provisions of chapter 375 of the Acts of 1888. For this purpose, and to make the necessary investigations in order to advise cities, towns, corporations and individuals in regard to the best methods of assuring the purity of intended or existing water supplies and the best method of disposing of sewage, and to carry out the other provisions of chapter 375 of the Acts of 1888, the Board estimates that the sum of $30,000 will be required.

Expenditures.

The work of the Board is conducted under the provisions of several statutes, and for its different departments of work three appropriations are annually made, one for the general work of the Board, one for the inspection of food and drugs, and a third for carrying out the provisions of chapter 375 of the Acts of 1888, relating to the protection of the purity of inland waters. In addition to the foregoing, special appropriations have been made from time to time, as occasion has demanded, for the purpose of enabling the Board to conduct special lines of investigations.

The appropriations for the different departments of work in 1896 were as follows: —

For the general work of the Board,	$15,800
For food and drug inspection,	11,500
For carrying out the provisions of chapter 375, Acts of 1888,	30,000
Total,	$57,300

The expenditures in 1896 under the foregoing appropriations were as follows: —

General Expenditures Sept. 30, 1895, to Sept. 30, 1896.

Salaries,	$4,829 99	
Travelling expenses,	562 69	
Stationery,	261 67	
Printing,	1,248 58	
Books, subscriptions and binding,	345 18	
Typewriting and library supplies,	17 76	
Telephone and telegraph messages,	70 60	
Postage and postal order,	237 85	
Express,	166 92	
Advertising,	9 00	
Zinc plates, prints and photo-micrographs,	83 28	
Extra services,	10 50	
Services of messenger,	400 50	
Drafting diagrams,	23 50	
Special investigations,	915 45	
For revision of manual of health laws,	175 00	
Rent of chemical laboratory,	62 50	
Weather bureau reports,	60 00	
Samples of diphtheria antitoxin, vaccine lymph and opium cure for analysis,	17 93	
Sundry office supplies and incidental expenses,	157 81	
		$9,656 71

Expenditures at Bacteriological Laboratory.

Salaries,	$2,477 51	
Services,	56 05	
Travelling expenses,	42 42	
Labor (care of horses, etc.),	432 90	
Purchase of animals,	99 38	
Board of horses,	1,285 90	
Express,	27 76	
Postage,	2 17	
Rental of telephone,	60 67	
Telephone and telegraph messages,	1 05	
Ice,	15 10	
Mailing cases,	30 52	
Fitting up laboratory buildings, including labor and teaming,	901 19	
Apparatus, chemicals and laboratory supplies,	861 37	
Sundry incidentals,	75 60	
		6,369 59
		$16,026 30

Expenses under Chapter 375 of Acts of 1888 (Protection of Purity of Inland Waters) for Calendar Year 1896.

Salaries, including wages of laborers at Lawrence Experiment Station,	$23,043 10
Apparatus and materials,	3,207 39
Rent of rooms at Massachusetts Institute of Technology,	750 00
Rent of Lawrence Experiment Station,	150 00
Travelling expenses,	1,017 12
Express charges, freight and teaming,	792 64
Use of tools and office, Lawrence Experiment Station,	270 12
Books, stationery and drawing materials,	379 78
Maps, blue prints and photographs,	94 52
Paid for collecting samples of water,	49 00
Postage stamps,	30 87
Messengers, telegrams and telephone messages,	18 87
Printing,	196 15
Total,	$29,999 56

For Food and Drug Inspection for Year ending Sept. 30, 1896.

Salaries of analysts,	$4,500 00
Salaries of inspectors,	4,050 00
Travelling expenses and purchase of samples,	1,851 64
Apparatus and chemicals,	256 17
Printing,	42 85
Books,	20 00
Index cards and guides,	57 77
Expressage,	3 15
Extra services,	116 00
Sundry small supplies (bottles, etc.),	24 03
Total,	$10,921 61

HENRY P. WALCOTT.
HIRAM F. MILLS.
F. W. DRAPER.
GERARD C. TOBEY.
JAMES W. HULL.
CHARLES H. PORTER.
JULIAN A. MEAD.

Report of the Joint Board

upon the

Improvement of Charles River.

REPORT OF THE JOINT BOARD UPON THE IMPROVEMENT OF CHARLES RIVER.

To the Honorable the Senate and House of Representatives of the Commonwealth in General Court assembled.

The undersigned, members of the joint board, consisting of the Board of Metropolitan Park Commissioners and the State Board of Health, to whom was referred, by chapter 529 of the Acts of 1894, the investigation of the sanitary condition of Charles River and the preparation of plans for the improvement of the river and its banks from the line between Waltham and Watertown to Mother Brook in Dedham, and for the removal of any nuisances therefrom, respectfully submit the following report.

The two boards named in the act met for organization July 26, 1894. H. P. Walcott was elected chairman of the joint board, and H. S. Carruth secretary. Mr. Carruth resigned his position Jan. 1, 1896, and John Woodbury was chosen to succeed him. Messrs. Olmsted, Olmsted & Eliot were asked to consider the subject of the improvement of the river, and submit a report thereon. Mr. Eliot had been a member of the Charles River Improvement Commission, appointed under authority of chapter 390 of the Acts of 1891, and had subsequently been employed as consulting landscape architect in preparing the plans for the improvement of Charles River which were recommended by the joint board appointed to consider the same, and a report upon which was presented to the Legislature in April, 1894.

The condition of the river has been personally ascertained by members of the board at various times, and they have carefully considered the reports made to them by the experts employed, and have reached the following conclusions.

The position of the Charles River in its relation to the metropolitan district has, necessarily, a very great influence upon the health and comfort of the people living in its vicinity. So long as

the stream was comparatively unpolluted, its banks were occupied at eligible sites by dwellings of the better sort. The increase of pollution and the consequent nuisance occasioned by it have driven from the banks throughout the lower portion of the river those who could afford to establish new homes in more attractive places, and the houses once occupied by these people have been taken by a poorer population, or by manufactories that seek the stream for commercial advantages or to be at a distance from neighbors likely to complain of offensive processes incident to the business there carried on. In concluding their report, the joint board of 1894 made this statement: "Your board feels that no treatment of the Charles River can be entirely satisfactory which does not regard the condition of the river above and in Waltham. At the boundary of that city, by the terms of the act under which we are directed to make our investigation and report, our labors end."

It will be remembered that the plan submitted by the commission of 1894 called for the preservation of the public reservation along the banks of the river up to the line between the city of Waltham and the town of Watertown. At certain points this public reservation is bounded by existing streets; at certain other points new streets would have to be constructed, for the purpose of limiting the amount of land to be taken to the smallest area necessary to procure a satisfactory reservation. It is understood that the appropriation subsequently made by the Legislature of that year for the purpose of enabling the Metropolitan Park Commission to take such land was not sufficient to carry out the entire plan as recommended.

One of the disagreeable incidents of the failure to complete this plan is shown by the use of a portion of the low land near the river in Waltham for the erection of a manufacturing establishment, which is likely to be an injury to the appearance of the banks and the comfort of residents in the vicinity; and we take this occasion to again call attention to the necessity of securing the banks of the stream below the Waltham line and above the centre of Watertown from still further encroachment.

It must not be understood, from the language just used, that we wish to banish from the banks of the stream all manufacturing establishments. We recognize the necessity to many of them of the location which they now occupy; but it is also true that

there are located here some manufacturing establishments which almost of necessity involve a greater or less injury to the district in which they are placed, and it does not seem to us reasonable that the centre of one of the most attractive portions of the metropolitan area should be forever given up to uses for which many less attractive spots are equally available.

The first thing likely to impress a person looking at a map of the district above the dam of the Boston Manufacturing Company at Waltham is the large area occupied by the water surface of the river above that point. On any pleasant day of the warmer season of the year this surface is a resort for boats of every description, used for the purposes of innocent and healthful enjoyment, not only by the people of the neighboring towns but by visitors from the whole metropolitan district, and, if nothing else could be done, it would be the part of wisdom to take for public uses this area, at least. Almost the only circumstance which at present seriously impairs the attractiveness or the healthfulness of this water surface and the banks bordering it is the use made of the water by the manufacturing establishments which control the principal dam. Whenever the water is drawn several feet below the level of the top of the dam, as it occasionally is in the seasons of protracted drought, the muddy banks or shores are exposed. As the stream for a large part of its course is still the public sewer of the district, much putrescible animal and vegetable matter is deposited upon these exposed banks and soon enters into decomposition, becoming a source of discomfort and positive injury even to the health of those who visit the stream for purposes of recreation or who live upon its banks.

To take such control of the stream as would prevent material changes in the level above this dam would probably inflict at most only a slight damage upon this manufacturing industry. It is a damage, however, that can readily be estimated and easily paid for. The limit which we should recommend to be placed upon the water of the river at this point and at all points where dams exist is that the establishments should be restrained in their use of the water of the river to the actual capacity of the river. That is to say, a diurnal variation of the surface of the water of the river is unavoidable, and does not appear to us to be the source of danger; but the river should at no time be so far drawn upon during the hours of

use of the water that the volume of water thus used could not be replaced by the accumulation through the portion of the day when the water is not used.

If it were possible to actually take possession of a strip of land on both banks of the river above the more closely built up portions of the city of Waltham, we believe, having regard to a long future, that it would be a wise investment; and we advise that some portions of the banks of the river should now be taken, either because they are so attractive in themselves that the loss of their attractiveness would be a serious injury to the appearance of the district, or because they are so unattractive that they are necessarily of small value, and likely to be occupied by objectionable establishments and residences.

In few districts in the metropolitan area have the residents themselves shown a more unselfish interest in the development of their local public grounds than along the banks of this stream, and the river is used as a place of healthful recreation by crowds drawn from beyond the limits of the towns that border upon the stream.

With that inevitable growth of population that is sure to come, the importance of this territory lying in the heart of the metropolitan district must year by year grow, and the difficulties of obtaining a public ownership just as rapidly increase.

Aside from the æsthetic and recreative interest which the beautiful shores of this river possess, and paramount to it, is the question of their healthfulness; and in this relation no disease has in recent years attracted more attention, or deserved more, than intermittent fever, or the disease due to the so-called malarial influences. The real importance of this disease cannot be measured by the deaths which are recorded as due to it. The disabling effects of it cling to the unfortunate subject for years, destroy the capacity for work and diminish the enjoyment of life. Communities which have long suffered from the disease would consider no expenditure of money extravagant which would free them from it; and portions of this district have already suffered enough in recent years to realize how grievous the hardships inflicted by a perhaps unnecessary malady are.

Amid all the uncertainties that surround the origin of the disease, the experience of mankind is united upon this, that variations in the water level of a stream or pond create conditions favorable

to the spread of malaria. Nowhere in the district about Boston are these conditions of a variable water level, at the season of the year when the malarial influences are most active, more marked than above the dam at Waltham. The large amount of organic matter necessarily present in the stream undoubtedly contributes something to the danger. So long as the banks are covered by water the processes of decomposition go on slowly, but on the exposed shores sun and air hasten on these processes of decay, with results which the people have always instinctively and justly feared.

These considerations emphasize the desirability, from the sanitary point of view, of maintaining the river's surface at a level as nearly uniform as possible, and in this matter the interests of public health and popular recreation concur.

In November, 1894, the State Board of Health issued a circular, which was addressed to physicians living in the cities and towns bordering upon the Charles River from Watertown to Dedham, for the purpose of obtaining information in answer to the following questions: —

1. When did intermittent fever first appear in your town, judging from your own observations?
2. Has it been more or less prevalent in your town during the past five years than previously?
3. Have any means been taken for its prevention, such as the drainage of wet lands, or other methods of improvement?

Fifty-seven physicians replied to these circulars, many of them very fully. The compilation of the replies was intrusted to Dr. J. J. Thomas, who also visited personally all of the infected districts. Replies were received from West Roxbury, Jamaica Plain, Brookline, Dedham, Dover, Needham, Waltham, Wellesley and Weston.

The occurrence of a few scattered cases in these towns from 1875 to 1885 "points to the presence of infected foci which, under favorable conditions, have become starting-points for its spread in the infected region."

The following summary gives the results of the replies to the second question, relative to its comparative prevalence in the five years (1890–94): —

Total Reported Cases, by Years.

YEARS.	Cases.
1890,	442
1891,	659
1892,	1,355
1893,	1,291
1894,	1,236
Total,	4,983

Prevalence, by Towns (1890–94).

CITIES AND TOWNS.	Cases reported.	Population (1890).	Ratio per 1,000 of Population.
Brookline,	45	12,103	3.96
Dedham,	12	7,123	1.68
Dover,	–	727	–
Needham,	62	3,035	20.40
Newton,	4,266	24,379	175.00
Waltham,	434	18,707	23.10
Wellesley,	58	3,600	16.10
Weston,	100	1,664	60.10

Nearly ninety per cent. of the reported cases occurred during the months of May, June, July, August, September and October.

In regard to the condition of the land near the river, Dr. Thomas says: "Both along the river itself and beside the various tributary streams is found much swampy and poorly drained ground. Not only is this true, but in many places the river itself spreads out over

a considerable area, forming extensive shallows surrounded by a wider or narrower strip of marsh. At seasons when the water is low, many of the shallows are exposed, or partly exposed, to the air and sun, while retaining abundance of moisture; in other words, forming most favorable culture grounds for the malarial parasite. This exposure of large areas of surface, when the level of the water is lowered but a few inches, is seen not only in the bed of the Charles River but along many of its tributaries and in many of the ponds which lie scattered through the whole region, and even more in the case of artificial reservoirs constructed for manufacturing purposes, or for supplying water to neighboring towns and cities."

Two methods occur to us by which the preservation of the attractive features of the stream may be secured; one by actual purchase of so much of the river banks as may be necessary for this purpose, the other by some arrangement with the riparian owners, by means of which the banks of the river, to an appropriate distance from the stream, shall be controlled in such manner as not to interfere with full private enjoyment of them, but at the same time to prevent, from the public point of view, a harmful use of them.

Some of the higher banks of the stream are now in the hands of individuals who have built expensive houses and laid out ornamental grounds; for the present, at least, the interests of these owners are the same as those of the public, — the preservation of the river with all its attractive features. To them, therefore, the proposition to establish a line along the banks of the stream within which no changes shall be made without the consent of some public authority acting in the interests of all would be a benefit rather than a hardship, for they would be protected against injurious changes upon neighboring estates. It would not be advisable, in our opinion, to allow the public any right to enter upon the territory thus reserved, for there should at the same time be secured at convenient and attractive points sufficient areas for all the reasonable uses to which this river is now put, — uses which would be indefinitely multiplied in case the natural beauties of this district are maintained.

Estimates which have been made by persons in whose knowledge of the territory in question we have full confidence show that sufficient land might be acquired by purchase, where actual public ownership seems essential, and control of certain other high-priced or developed lands secured, the possession of which by the public

is not requisite unless an inferior use of them is feared, for a sum of money not exceeding $300,000. In this sum are included the probable expenses of building some simple contrivances for the easy transfer of boats over the successive dams upon the stream.

To obtain the various results, the necessity of which has been thus briefly stated, it is, in our opinion, imperative that the following steps should be taken: —

1. That the high-water surface of the Charles River, from the dam at Watertown up to the Dedham line, should be made a portion of the metropolitan park system; that measures should be taken for securing a water level as nearly permanent as possible throughout the warmer months of the year; that arrangements should be made for the convenient transfer of boats over the dams on the river.

2. That certain lands be taken upon the banks of the river for places of public resort and convenience, and that rights be taken in all the remaining frontage on the river for the purpose of preventing obnoxious uses of the same.

3. That the whole area so secured be placed under the control of some public authority having power to protect and improve it.

HENRY P. WALCOTT, *Chairman*,
PHILIP A. CHASE,
WILLIAM B. DE LAS CASAS,
ABRAHAM L. RICHARDS,
AUGUSTUS HEMENWAY,
EDWIN B. HASKELL,
Board of Metropolitan Park Commissioners.

HIRAM F. MILLS,
FRANK W. DRAPER,
GERARD C. TOBEY,
JAMES W. HULL,
CHARLES H. PORTER,
JULIAN A. MEAD,
State Board of Health.

REPORT

OF THE

STATE BOARD OF HEALTH

UPON THE

SEWERAGE OF THE CITY OF SALEM AND THE TOWN OF PEABODY.

REPORT

OF THE

STATE BOARD OF HEALTH

UPON THE

SEWERAGE OF THE CITY OF SALEM AND THE TOWN OF PEABODY.

To the General Court of Massachusetts.

The State Board of Health has investigated and considered a general system of drainage and sewerage for the city of Salem and the town of Peabody, as authorized and directed by chapter 112 of the Resolves of 1895 and chapter 69 of the Resolves of 1896, and submits the following report.

The resolves under which the work has been done are as follows: —

[CHAPTER 112, RESOLVES OF 1895.]

RESOLVE RELATIVE TO SEWAGE DISPOSAL AND DRAINAGE IN SALEM AND PEABODY.

Resolved, That the state board of health is hereby authorized and directed to consider and report a general system of drainage and sewerage for the city of Salem and town of Peabody, or for such parts of said city and town, not all of which shall be wholly within either of said municipalities, as may, in the opinion of said board, be best drained by said system. It shall be the duty of said board: — First. To designate the portions of said city and town which shall be tributary to and embraced in the district and system to be so reported, and to define the same by their report, with plans and maps. Second. To define and show, by suitable plans and maps, such trunk line and main branches as it shall recommend to be constructed, with outlet. Third. To consider the various methods of disposal of sewage and the application of such methods to any portion of the territory herein mentioned; and to define the methods by which said city and town, or

parts of said city and town, may utilize said trunk line and main branches as an outlet of a system of sewerage and drainage for said city and town and said parts of said city and town respectively; and to show the same by plans and maps. Fourth. To employ such engineering and other assistance as may be necessary for carrying out the objects of this resolve, and to cause such surveys and levels to be made as will enable said board to determine with accuracy the location and grades of said trunk line and main branches, and also such surveys and levels in said city and town, and parts of said city and town, as will enable said board to determine with accuracy the methods by which said city and town, and parts of said city and town, may respectively utilize said trunk line and main branches, and to report such methods by plans showing the main lines by which each may so provide for itself a system of sewerage and drainage with its outlet into said trunk line or main branches. Fifth. To define the size and capacity of said trunk line and main branches, and the materials of which they should be constructed and manner of construction, and such other particulars as will enable said board to determine the probable expense thereof; and to ascertain and report the cost of the construction of said trunk line and main branches and outlet, and to report a recommendation as to the methods of apportioning said cost. All expenses incurred by said board under the provisions of this resolve shall be reported to the governor and council, and all such expenses when approved by them shall be paid out of the treasury of the Commonwealth; but the total expenditure shall not exceed three thousand dollars. The Commonwealth shall be reimbursed for such expenditure under this resolve as shall have been approved by the governor and council in the following manner: — The town of Peabody and the city of Salem shall each pay such proportion of the above expenditure as the said board shall deem to be equitable, and the amounts so to be paid by each shall be assessed and collected by the treasurer of the Commonwealth at the time required for the payment of the state tax of said town and said city respectively. Said board shall make all reports required by this resolve to the general court on or before the first Wednesday of January in the year eighteen hundred and ninety-six. [*Approved May 29, 1895.*

[Chapter 69, Resolves of 1896.]

RESOLVE EXTENDING THE TIME FOR THE REPORT OF THE STATE BOARD OF HEALTH RELATIVE TO SEWAGE DISPOSAL AND DRAINAGE IN SALEM AND PEABODY.

Resolved, That there be allowed and paid out of the treasury of the Commonwealth a sum not exceeding one thousand dollars, to be expended by the state board of health in continuing the investigations relating to a general system of drainage and sewerage for the city of Salem and the town of Peabody, provided by chapter one hundred and twelve of the resolves of

the year eighteen hundred and ninety-five, said amount being in addition to the three thousand dollars provided for in said resolve; the Commonwealth to be reimbursed for such additional expenditure herein provided for as shall be approved by the governor and council, in the same manner as provided in said resolve. The time allowed for the completion of the report of said state board of health relative to said general system of drainage and sewerage for the city of Salem and the town of Peabody is hereby extended, and said board is directed to submit said report in print, together with plans and estimates of cost, to the city of Salem and the town of Peabody on or before the first day of July in the present year, and to present a duplicate of said report to the general court on or before the first Wednesday of January in the year eighteen hundred and ninety-seven. [*Approved April 17, 1896.*

The nuisances caused by the discharge of sewage about Salem have been the cause of complaint for many years, and much money has been expended in various ways to improve the sanitary condition of the city. The shores about Salem are generally low, and large areas of flats are exposed at low tide. The flats in many places have become offensive on account of the discharge of sewage upon them, and new sewers have been built from time to time to remove the sewage to other points of discharge.

The worst nuisance existing at present is found in the North River. This stream is the natural drain of a territory containing numerous tanneries and similar establishments, sewage from which is discharged directly into the stream. The sewage from these works is of a particularly offensive character, and contains a much greater amount of putrescible organic matter than is contained in an equal quantity of ordinary domestic sewage. Several house sewers are also discharged into this stream, but the quantity of house sewage is probably very small compared with the quantity of manufacturing sewage.

Above North Street bridge the North River is confined generally in a narrow channel, while below the bridge there is a wide tidal estuary. The slackening of the current of the river when it enters this estuary causes a deposit of the heavier matters from the sewage, and it is understood that dredging has been resorted to from time to time in order to remove deposits from the bottom of the river in this vicinity.

Nuisances exist in several other places about Salem, particularly in the South River and in Palmer's Cove. An intercepting sewer

recently constructed removes a small portion of the sewage formerly discharging into the South River and some of the sewage formerly discharging directly into the harbor to a point of discharge near the Philadelphia & Reading coal wharf; but this place of discharge is not likely to prove satisfactory, on account of the large areas of flats in the vicinity of the outlet and the slow currents in the harbor. Should the present conditions continue, the nuisances will inevitably grow worse with the increase of population and the consequent increase in the quantity of domestic and manufacturing sewage that will be discharged into the streams and tidal waters about Salem.

The Board has not thought it necessary to describe in further detail the existing nuisances, since the conditions are well known to the inhabitants of Salem and Peabody, and several attempts have been made in the past to provide a satisfactory remedy. Permanent relief from existing nuisances can be obtained only by purifying the sewage before discharging it near the shores, or by conveying it in a crude state to some point of discharge at such a distance from inhabited shores that it will become well diluted before any portion of it can reach any shore.

From a consideration of the whole question, it is evident that the most appropriate and least expensive method of disposing of the domestic and manufacturing sewage of Salem and Peabody is by discharging it into the sea, rather than by attempting to purify it upon land or to clarify it by removing the suspended matters so far as possible by the use of chemicals.

In order to determine the most appropriate point of discharge in Salem harbor, a careful study of the tidal currents at several points has been made by means of floats. The results of these experiments show that the tidal currents in Salem harbor are slow and weak, as compared with those in Boston harbor, at the places where the north and south metropolitan sewer systems discharge; and no strong tidal current is found at any point near the shore into which the quantity of sewage that is likely to be produced by Salem and Peabody could be discharged without danger that some of the solid matters from the sewage might be deposited upon the shores in the vicinity of the outlet. The experiments show that the sewage could be safely discharged at Great Haste Island at all stages of the tide without danger that it would produce a nuisance upon any shore, and

this is the most appropriate place for the disposal of the sewage; but the cost of conveying the sewage to this point would be so great for the present population that it is desirable to select a point nearer the shore, even though the conditions are somewhat less favorable for the satisfactory disposal of the sewage. Float experiments indicate that if the sewage should be discharged at Great Aqua Vitæ Beacon, about half a mile east of Fort Pickering, there is danger that with easterly or northerly winds floating matters from the sewage might be carried to the shore of Salem harbor, or even to the Marblehead shore on the south; but the wind would be likely to have less influence upon a body of water covered with sewage than upon the floats, and probably little if any trouble would be experienced from discharging the sewage at this point for several years. In view of the circumstances, it is recommended that the works be built to discharge the sewage at Great Aqua Vitæ Beacon, and if this point of discharge becomes objectionable the outlet can then be extended to Great Haste.

Investigations were also made to determine the feasibility and probable cost of disposing of the sewage by discharging it at a favorable stage of the tide at some point close to the shore of Salem harbor, and providing a reservoir to hold the sewage between the tides. A location for a reservoir was found upon Winter Island, and the investigations indicated that it would be practicable to dispose of the sewage by discharging it off Fort Pickering Light upon the outgoing tide; but on account of the extra cost of the reservoir, this plan would be more expensive than the plan for discharging the sewage continuously at Great Aqua Vitæ Beacon, and it would be less satisfactory.

The proposed sewer begins at the junction of Walnut and Central streets, near Peabody Square, in the town of Peabody, and extends through the valley of the North River into Salem, crossing the main line of the eastern division of the Boston & Maine Railroad, near the northerly end of the tunnel, and along the shore of Collins Cove to a proposed pumping station on the north-easterly side of the Philadelphia & Reading coal wharf at the shore of Salem harbor. The elevation of the bottom of the sewer at the point of beginning is 12.47 feet above mean low tide, and its diameter is 3 feet 2 inches. The grade of the bottom at the pumping station is 0.67 of a foot above mean low tide, and its diameter 6 feet.

At the pumping station all of the sewage will be raised by pumps to a height varying with the height of the tide, and will be discharged at all stages of the tide at Great Aqua Vitæ Beacon.

The sewer at its lower end at the pumping station has a capacity sufficient to remove 38,000,000 gallons of sewage in twenty-four hours if running two-thirds full, or 48,000,000 gallons if running full. The capacity of the sewer has been based upon an estimated daily quantity of 80 gallons of ordinary sewage per inhabitant for a population of 102,000, which may be reached at the present rate of growth in 1935, and upon a liberal estimate of the amount of manufacturing sewage that may be produced in the district within that time, with allowances for irregularity in the discharge of sewage into the trunk sewer.

The main trunk sewer is designed to receive sewage only, and the entrance of large quantities of storm water should be prevented. To this end, the connections of existing sewers in Salem, which now receive both sewage and surface water, with the main trunk sewer, should be provided with automatic regulators, as is done in the case of connections between sewers which receive storm water and the intercepting sewers in the city of Boston and in the metropolitan sewerage district, in order to prevent the flooding of the main trunk sewer and other tributary systems by these sewers at times of storm. The mingled sewage and storm water from existing sewers may at such times be allowed to discharge at present outlets.

It will also be necessary to limit the quality of the sewage that may enter the main trunk sewer or any of its tributaries so as to exclude substances from manufacturing sewage that will not flow through the sewers or will have to be taken out of the sand-catcher, and all matters that may clog the pumps.

In some mechanical and manufacturing processes a considerable portion of the water used may not be fouled to an appreciable extent, and such water should not be discharged into the sewers, but should be disposed of by discharging it into the sea or into some suitable drainage channel.

The total cost of the main trunk sewer, with pumping station and other appurtenances complete, having an outlet at Great Aqua Vitæ Beacon, is estimated to be $440,116.

On account of the topography of Salem and Peabody, and the fact

that only two municipalities are mentioned in the resolve, no main branches are found to be necessary, within the meaning of the resolve.

In Peabody no general system of sewers has as yet been constructed, and it is recommended that when the town shall provide itself with a system of sewers, the separate system be employed, and that surface water and, so far as possible, ground water be excluded from the sewers. In Salem some of the existing sewers will, by means of extensions, serve as main lines of sewerage for the city.

In extending the present sewerage system of Salem it is recommended that all new systems of sewers be constructed upon the separate plan and that storm water be wholly excluded. It is also very desirable that the area from which storm water is admitted to existing sewers should be restricted as much as is practicable, in order to avoid the expense of pumping considerable quantities of storm water and to limit as much as possible the discharge of crude sewage in the vicinity of the shores at times of storms.

The resolves under which this work has been done require that the Board shall ascertain and report the cost of construction of a trunk line sewer and main branches and outlet, and report a recommendation as to the method of apportioning said cost. In the case of the metropolitan sewerage system, which includes the city of Boston and twenty-one neighboring municipalities, the act providing for the construction and operation of the system contains a provision that there shall be a new apportionment of the charges for interest, sinking fund and maintenance once in five years; and a precedent for the apportionment of the cost of construction and of maintenance and operation of the metropolitan sewers among the several cities and towns composing the metropolitan sewerage district has already been well established by the reports of two commissions appointed by the supreme court to make such apportionment. The same method of apportionment has been adopted by both commissions, and is as follows: charges for interest and sinking fund, which represent the cost of construction of the works, are based upon the valuation of the municipalities included within the district, and the charges for maintenance and operation are based upon the population. In the cases of cities or towns portions of which cannot be drained by the metropolitan system, the valuation and population

of such portions were excluded in favor of the city or town within whose limits these areas are situated.

There appears to be no more equitable method of apportioning the cost of construction of the Salem and Peabody system between these municipalities, and accordingly this method is recommended. The property valuations used by the commission appointed to apportion the cost of metropolitan sewers, which reported recently (the report being dated Oct. 16, 1896), are those established by chapter 90 of the Acts of 1895, and the valuations of Salem and Peabody established by that act are as follows: —

Salem,	$30,649,889 00
Peabody,	8,039,864 00

The proposed drainage district of Salem and Peabody includes the whole of Salem, but 6.6 square miles, or 4,224 acres, in the town of Peabody will not be drained by the proposed plan. It is therefore necessary, in deciding the proportion that Peabody should pay toward the cost of the works, to determine the valuation and population of the town, exclusive of the portion outside the proposed sewerage district.

The valuations furnished by the Tax Commissioner and established by chapter 90 of the Acts of 1895 give the total valuations of the cities and towns, and it is not possible to determine exactly the valuation of the territory in the town of Peabody which will not be reached by the proposed sewer. The most accurate approximation that could be made appeared to be the following: it was possible to obtain from the assessors of Peabody the total valuation of real and personal estate in the whole town and in the portion of the town outside the proposed sewerage district for May 1, 1895. It was also possible to obtain from the Tax Commissioner the total amount of bank and corporation stock belonging to Peabody in 1894; and one of the Peabody assessors, after an examination of the records of the Tax Commissioner, made a statement as to the amount of this stock that was chargeable to the portion of the town outside the proposed sewerage district. The percentage of the total valuation of the town that is represented by the valuation of the portion outside the proposed sewerage district has been obtained from these amounts, as follows: —

Assessors' valuation of all real and personal estate in Peabody (1895),	$7,598,750 00	
Tax Commissioner's valuation of all corporation and bank stock belonging to Peabody (1894),	786,375 00	
Total for town of Peabody,		$8,385,125 00
Assessors' valuation of real and personal estate in Peabody outside of sewerage district,	$819,250 00	
Tax Commissioner's valuation of corporation and bank stock belonging in Peabody, outside of sewerage district ascertained as above (1894),	105,700 00	
Total for area in Peabody outside of sewerage district,		924,950 00
Net valuation of sewerage district,		$7,460,175 00
Percentage of total valuation in Peabody, that is, outside of sewerage district,		11.03084

Deducting this percentage from the total property valuation of Peabody made by chapter 90 of the Acts of 1895, which is $8,039,-864, the total valuation of property in the proposed sewerage district is as follows: —

Salem,	$30,649,889 00
Peabody,	7,152,999 00
Total,	$37,802,888 00

The percentage of each to the total and the proportion which each municipality should pay toward the cost of the works under this apportionment at the present time is as follows: —

Salem,	81.0782 per cent.
Peabody,	18.9218 per cent.

The estimated annual cost of maintenance, including all running expenses and repairs, of the trunk sewer, pumping station and harbor outfall for Salem and Peabody, discharging at Great Aqua Vitæ Beacon, is $12,000. The present quantity of sewage produced by Salem and Peabody is estimated at 6,250,000 gallons per day, and the estimate for maintenance is based upon a quantity of sewage equivalent to 10,000,000 gallons per day, which may represent the average quantity of sewage to be disposed of for ten or more years in the future.

In estimating the proportion which each municipality should pay toward the maintenance and operation of the system, the basis used by the commissioners who apportioned the cost of metropolitan

sewers, as already stated, is the population; and here, also, it is necessary to make allowance for the number of people in the portion of Peabody outside of the proposed sewerage district. It has not been thought necessary to attempt to determine this population with great accuracy, since an accurate estimate can be made when occasion may require. By a count of the houses in the district outside of the area draining toward the proposed sewer, it is found that there are about 103 houses in this district. Allowing a population of 5 persons to each house, the number of people in this district would be 515. Deducting this number from the population of Peabody, as determined by the census of 1895, the estimated number of people within the proposed sewerage district in the town of Peabody is 9,992.

Dividing the cost of maintenance and operation upon the basis of population, estimated as above, the proportion which Salem and Peabody would pay is shown by the following table: —

	Population, 1895.	Per Cent. of Cost of Maintenance.
Salem,	34,473	77.53
Peabody,	9,992	22.47

In constructing public works of this magnitude it is customary to raise the money for the work by issuing bonds, and in cases like the one under consideration, where the works are expected to serve for many years in the future, bonds are issued for long terms. Payment for the bonds is provided for generally by payments to a sinking fund, the payments being so arranged as to extinguish the debt at the maturity of the bonds. In order to indicate approximately what the probable yearly cost to each municipality would be, should bonds be issued for the construction of the works and a sinking fund created to pay them at maturity, the following estimate has been prepared. The interest charges have been assumed to be 4 per cent., which appears to be the average rate of interest on town and city bonds issued under favorable conditions within the last few years, although such bonds would command a premium at the present time; and the sinking fund has been estimated at 1¼ per cent. annually, which would extinguish the debt in forty years.

Estimated yearly cost for interest and sinking fund, at 5¼ per cent., is	$23,106 09
Estimated yearly cost of maintenance is	12,000 00
Total,	$35,106 09

Dividing these two amounts between Salem and Peabody, on the basis of apportionment already given, the total yearly cost and the cost per capita tax to each municipality would be as follows: —

	Yearly Cost for Interest and Sinking Fund.		Yearly Cost for Maintenance.		Yearly Cost for Interest, Sinking Fund and Maintenance.	
	Total.	Per Capita.	Total.	Per Capita.	Total.	Per Capita.
Salem, . . .	$18,734 00	$0 54	$9,303 60	$0 27	$28,037 60	$0 81
Peabody, . .	4,372 09	44	2,696 40	27	7,068 49	71

Should the State create a district, and should it construct and operate the main sewer system herein proposed in the same manner as in the case of the metropolitan sewerage district, and charge the amounts for interest, sinking fund and maintenance to the city of Salem and the town of Peabody, a considerable saving would be made in the cost of interest and sinking fund to Salem and Peabody.

In the case of the metropolitan sewerage loan, the bonds bear interest at a rate of 3 per cent., but at the present time the rate of interest upon State bonds would probably be higher. Assuming that the rate of interest would be 3½ per cent. (at which rate the bonds would command a premium at present), and that the payment to the sinking fund would be 1¼ per cent., as before, the annual cost to Salem and Peabody would be: —

Estimated annual cost of interest and sinking fund, at 4¾ per cent., is	$20,905 51
Estimated annual cost of maintenance is	12,000 00
Total, ...	$32,905 51

This would be at a rate of $2,200.58 per year less than if the towns raised the money themselves; or, in other words, the use of the credit of the State would reduce the yearly cost for interest and sinking fund by about 9½ per cent.

The total cost and cost per capita to each municipality would then be as follows: —

	Yearly Cost for Interest and Sinking Fund.		Yearly Cost for Maintenance.		Yearly Cost for Interest, Sinking Fund and Maintenance.	
	Total.	Per Capita.	Total.	Per Capita	Total.	Per Capita.
Salem, . . .	$16,949 81	$0 49	$9,303 60	$0 27	$26,253 41	$0 76
Peabody, . .	3,955 70	40	2,696 40	27	6,652 10	67

By a provision of the resolves under which this investigation has been made, it is required that the town of Peabody and the city of Salem shall each pay such proportion of the expenditure as the Board shall deem to be equitable.

It is deemed equitable that the cost of the preliminary investigation should be provided for in a manner similar to that which would probably be used in providing for the payment of the cost of the works; that is, that the cost of the investigation should be divided upon the basis of the valuation of the portions of each municipality included within the proposed drainage district. The appropriations and total cost of the work have been as follows: —

Appropriations, ...	$4,000 00

Expenditures.

Salaries of engineers and assistants, ...	$3,301 50
Travelling expenses, ...	88 14
Labor in making borings, ...	345 54
Pipe and material for borings, ...	29 49
Glass bottles for samples of soil from borings, ...	8 88
Teaming, ...	10 00
Lumber, ...	7 75
Hardware, ...	5 41
Tin cans for floats, ...	4 25
Drafting, ...	80 00
Rental of instrument, ...	15 00
Drawing materials, ...	13 11
Maps and map mounting, ...	17 85
Stationery, postage and money order, ...	2 50
Expressage, ...	3 11
Telephone and telegraph messages, ...	1 53
Miscellaneous incidentals, ...	9 45
Total expended for surveys and investigations, ...	$3,943 51

Dividing this amount on the basis of valuation of each municipality, the amount to be paid by each as its share of the cost of surveys and investigations is as follows: —

	Percentage to be paid.	Total.
Salem,	81.0782	$3,197 33
Peabody,	18.9218	746 18

To these amounts there is to be added, under a ruling of the State Auditor, the cost of printing reports for each municipality, with maps and plans, making the total assessment of each municipality as follows: —

SALEM.

For proportion of cost of surveys and investigations,	$3,197 33	
For printing of 730 copies of report (including plans),	223 29	
Total assessment,		$3,420 62

PEABODY.

For proportion of cost of surveys and investigations,	$746 18	
For printing of 475 copies of report (including plans),	145 29	
Total assessment,		$891 47

and the Board deems it equitable that the city of Salem shall pay $3,420.62 and the town of Peabody $891.47 as their proportion of the above expenditures.

The reports of Mr. G. A. Kimball, the engineer employed by the Board to conduct the investigations and prepare plans of the works, and of Mr. Joseph P. Davis, the consulting engineer of the Board, appear in the special report presented to the Legislature.

H. P. WALCOTT,
H. F. MILLS,
F. W. DRAPER,
G. C. TOBEY,
J. W. HULL,
C. H. PORTER,
J. A. MEAD,
State Board of Health.

REPORT

OF THE

STATE BOARD OF HEALTH

UPON THE

SANITARY CONDITION AND IMPROVEMENT OF THE NEPONSET MEADOWS.

REPORT

OF THE

STATE BOARD OF HEALTH

UPON THE

SANITARY CONDITION AND IMPROVEMENT OF THE NEPONSET MEADOWS.

To the Honorable the Senate and House of Representatives of the Commonwealth in General Court assembled.

The State Board of Health, acting under chapter 83 of the Resolves of 1895, has investigated the sanitary condition of the meadows on the Neponset River in the towns of Canton, Sharon, Norwood, Dedham, Milton and Hyde Park, and herewith submits the results of that examination, together with recommendations for the improvement of the sanitary condition of these meadows and the removal of nuisance therefrom.

These meadows cover an area of 3,662 acres. Of this surface hardly more than 600 acres appear to be in a condition adapted to profitable agriculture. From the remaining territory crops of hay are obtained occasionally, or not at all. The condition of the meadows seems to have grown worse in recent years, and many of the larger owners have abandoned the attempt to secure some degree of drainage by the maintenance of open ditches, on account of the steadily diminishing returns from the crops.

At an earlier day and for a succession of years a grass known as the fowl meadow or false redtop grew on these meadows, — the first name still is used to designate the locality, — and, proving to be a valuable forage plant, gave a high value to the lands upon which it flourished. The present condition of the territory, however, is evidently not so favorable as it once was to the growth or preservation of this grass, and it is also probable that cheaper transportation

has brought into this market hay of a better quality at a price lower than that at which this marsh grass could be profitably sold. As a result of either or both of these conditions, the value of these lands has steadily fallen.

While it might be expected that the meadows should be uninhabited, as they are, it is not at first so easy to understand why the higher grounds in the vicinity should be still unoccupied by the rapidly increasing suburban population which seeks and finds acceptable building sites at distances from the business centre of Boston more considerable than any portion of the area in question. The facilities for transportation by convenient railroads are at least as good as can be found in other directions from Boston, and the towns which make up the district appear to be desirable places of residence. There has, however, for years existed a popular belief that the meadows have become a source of sickness, and this feeling seems recently to have increased. Intelligent observers report that these meadows are at times the source of disagreeable odors and the direct cause of much sickness. The examinations by this Board have shown that the upper portion of the stream was very seriously polluted, and the opinions of the physicians residing and practising in the valley, which have been from time to time collected, indicate a general belief on the part of the medical profession that the conditions affecting health here are more unfavorable than they formerly were.

The valley of the Neponset River has twice before been the subject of extended examinations by the State authorities, — first by the State Board of Health in 1875, and subsequently by the Massachusetts Drainage Commission in 1885. In addition to these examinations, a description of the Neponset River basin, with statistics relating to its pollution and analyses of its waters, may be found in the special report of the State Board of Health on the examination of water supplies, 1890, and in the twenty-second annual report of the Board. So much of the great body of facts collected by the Board as may be necessary for the purposes of this report will be found in the report of the engineer, contained in the special report presented to the Legislature.

The earliest notices of these meadows give evidence that even then there were prolonged periods of flooding, and that it was found necessary to clear the bed of the stream from time to time of its obstructions, consisting of fallen trees and shrubs with the entangled rubbish. With the increasing pollution of the stream, however,

another and more persistent interference with the current became operative. The waste matters of human life and the refuse of manufactories, when added to the waters of the stream, became efficient fertilizers for the vegetable substances that find a home there, and their increased quantity became a mechanical hindrance to the current, promoted deposits in the bed of the stream, and finally, by their decay, gave to the atmosphere odors which common experience as well as scientific knowledge declare to be injurious to health.

An accurate estimate of the amount of sickness produced by the condition of these meadows, founded upon statistical inquiry, is almost impossible, and largely for the reason that the common-sense of the people and their freedom to select more salubrious locations have prevented settlements in the immediate vicinity of these low lands. We find here, at an average distance of thirteen miles from the State House, an area of more than eleven square miles which is uninhabited. The people have not had the same objections to residence near the great salt marshes which line our coast, where the conditions of flooding and soil moisture are apparently as serious as they can be in the Neponset valley, but are not associated with a seriously polluted water or excessive growth and decay of vegetable matters.

We are of the opinion that the condition of these meadows and of the beds, shores and waters of the Neponset River is injurious to the public health. The opinions of the physicians of this district, as ascertained by an inquiry instituted by the Board, are also distinctly to the effect that the conditions which now exist here are unfavorable to health and that the unhealthful conditions are increasing in amount from year to year.

One disease has attracted considerable attention in recent years in many portions of this State, — malarial fever, — and portions of this valley have suffered from it, and severely, when the limited population is taken into account.

One farm-house was found not far removed from the meadows, but lying many feet above their level, which, well built and well cared for, had failed to offer adequate protection against an influence which, originating beyond the immediate surroundings of the house itself, was sufficiently potent to affect more than half of the ten occupants of the house.

We find that malarial diseases are uniformly prevalent in the Neponset basin, though no distinct concentration of cases has been

anywhere observed except in the case of the farm-house above cited. This is a condition of things which points distinctly to some influence which pervades the whole district, and the obvious origin of such an influence is the condition of the Fowl Meadows, with the polluted river and large areas of stagnant water. While the current theories upon the subject of malarial diseases may sufficiently explain the occurrence of these diseases in a marshy region, with stagnating water and the inevitable accompaniment of decaying vegetation, we are well aware that future scientific examination may find the really essential factor in some hitherto unsuspected condition of such territories. But it fortunately is true that malarial diseases where once prevalent have disappeared upon the removal of conditions such as those now found through the Neponset valley, and that the general healthfulness has been distinctly and immediately increased thereby.

Attention is also called to the report contained in appendix prepared by the chemist of the Board.* With the co-operation of the owners of the larger manufactories on the river, a very complete examination has been made of methods for diminishing the pollution of the stream by treatment of the effluents from these establishments, and it has been found that these effluents, either by themselves or when mixed with ordinary town sewage, can be satisfactorily purified upon properly prepared sand filters. It is advisable, however, to remove by sedimentation from the factory effluent, before it reaches the filter, so much of the sludge contained therein as is possible. This sludge can be removed from the sewage by means of a settling basin of moderate dimensions, and, as it contains much more nitrogen than ordinary sewage, could probably be readily disposed of.

For the present, at least, the sparsely settled districts adjoining the meadows do not appear to be in pressing need of extended systems of sewerage; but the time will come when the same provision which is here recommended for the factory refuse should be made for the collection and purification of domestic sewage. There appear to be in the valley areas of land suited to intermittent filtration, and sufficient in quantity for the needs of the district.

Portions of the banks of the stream in the town of Hyde Park are at present in an unsanitary condition; but legislation subsequent to that authorizing this inquiry by the Board has provided a sufficient means for the relief of this state of things, through the construction of a sewer system having an outlet into the metropolitan system of sewerage.

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* This may be found in the special report of the Board upon the Neponset meadows, presented to the Legislature of 1897.

The measures which we recommend for the remedy of the conditions injurious to health now existing in the Neponset valley are these: —

First. — Such additional legislation as will prevent the entrance into this stream of sewage and manufacturing wastes which have not been satisfactorily purified.

Second. — The permanent removal of the flashboards of the dam of the Mattapan Mills, the enlargement of the cross-section of the river, together with a deepening and reconstruction of the channel at such places as may be found necessary for making a channel of such width and grade as will prevent the flooding of the meadows during the times of high flows in late spring and summer.

A conservative estimate of the cost of making this improvement, irrespective of land and water damages, is, in round numbers, $125,000. The engineer also presents some figures* to show the increase in the value of meadow lands reclaimed, and to this sum should also be added the enhanced value of the now neglected building sites immediately adjoining the meadows. It can thus be demonstrated, we think, that the work of improvement would be justifiable from a money stand-point alone. We have not considered it within our province to present the agricultural advantages of a drainage of this expanse of meadows. Land so well adapted, as this would be when drained, to the purposes of market gardening must always have a value near a great market far in advance of any price now paid for land in this district.

When we limit ourselves, however, to considerations of health, it scarcely seems necessary, now that a considerable portion of the State has acquired a knowledge of the depressing and disabling effects of malarial diseases, to insist upon the economical value of a freedom from the conditions that favor their prevalence. We do not hesitate, therefore, to recommend the improvement of this district, the healthfulness of which is vital to the immediate residents therein, as well as to the occupants, present and future, of the lands lying about it.

It will be remembered that, in accordance with the recommendations of the Massachusetts Drainage Commission, legislation was had now embodied in chapter 375 of the Acts of 1888. Under the provisions of this act the State Board of Health has the general oversight and care of all inland waters. The commission which suggested

* To be found in the report of the engineer, which accompanies the special document on the Neponset meadows, presented to the Legislature of 1897.

the legislation above referred to used these words in their report to the Legislature of 1886 : —

Let these guardians of inland waters be charged to acquaint themselves with the actual condition of all waters within the State as respects their pollution or purity, and to inform themselves particularly as to the relation which that condition bears to the health and well-being of any part of the people of the Commonwealth. Let them do away, as far as possible, with all remediable pollution, and use every means in their power to prevent further vitiation. They shall put themselves at the disposal of manufacturers and others using rivers, streams or ponds, or in any way misusing them, to suggest the best means of minimizing the amount of dirt in their effluent, and to experiment upon methods of reducing or avoiding pollution. They shall warn the persistent violater of all reasonable regulation in the management of water of the consequences of his acts. In a word, it shall be their especial function to guard the public interest and the public health in its relation with water, whether pure or defiled, with the ultimate hope, which must never be abandoned, that sooner or later ways may be found to redeem and preserve all the waters of the State.

The suggestions contained in these sentences have governed the action of this Board during the ten years which have passed since the State Board of Health was made the official guardian of the inland waters of the Commonwealth. It is our opinion that all reasonable efforts have been exhausted in the attempt to do away with the remediable pollution of these waters, and that the time has come when the State must take more effective measures for the prevention of the pollution of the streams not now used as sources of domestic water supply, but still capable of injurious effect upon the public health.

H. P. WALCOTT.
H. F. MILLS.
F. W. DRAPER.
G. C. TOBEY.
J. W. HULL.
C. H. PORTER.
J. A. MEAD.

Water Supply and Sewerage.

ADVICE TO CITIES AND TOWNS.

WATER SUPPLY AND SEWERAGE.*

[Report required by the provisions of chapter 375 of the Acts of 1888, entitled "An Act to protect the purity of inland waters, and to require consultation with the State Board of Health regarding the establishment of systems of water supply, drainage and sewerage."]

The following report contains a summary of the work of the State Board of Health during the year 1896, under the provisions of chapter 375 of the Acts of 1888, including the substance of the replies made by the Board to those cities, towns, corporations and individuals which have applied to the Board for its advice relative to systems of water supply, drainage and sewerage, under the requirements of this act, and of special acts which include a clause requiring the approval by the Board of plans and schemes relative to water supply and sewerage, together with a brief statement of the work done at the experiment station at Lawrence and in connection with the examinations of water supplies and rivers.

During the year 1896 public water supplies were introduced in the towns of Hatfield, Rutland, Weston and Winchendon, and important additions to the sources of many existing works were made. At the end of the year 1896 all of the 31 cities in the Commonwealth and 127 towns out of a total of 322 were provided with public water supplies. The total population of the communities having a public water supply is 89.8 per cent. of the total population of the State. There are now but 3 towns which by the census of 1895 have a population exceeding 3,500 which are not provided with a public water supply. The names of these towns, with their respective populations in 1895, are as follows: —

Towns.	Population.
Blackstone,	6,039
Barnstable,	4,055
North Andover,	3,569

* The first pages of this report were contained in a report made to the Legislature Jan. 11, 1897 (Senate Document, No. 4). A portion of the report then made, relating to the work done at the Lawrence Experiment Station, is not reproduced, because a more complete account of the work done at this place will be found in a subsequent part of this volume.

The flow of streams for the year 1896, as indicated by the Sudbury River, was slightly less than the normal for twenty-two years. The flow was greatly in excess of the normal in February, March and September, and slightly in excess in October. It was less than the normal in all of the remaining months, the most marked deficiency being in the months of April, May, July and August.

The chemical analyses of the water supplies and rivers of the State and of sewage and effluent from sewage disposal works have been continued during the year, 2,399 samples having been examined. The following is a classified list of the waters examined during the year:—

TABLE I.

From open and covered reservoirs for the storage of ground waters,	32	
From ground-water supplies,	413	
Special investigations of regular water supplies affected by tastes, odors, etc.,	24	
From ponds and storage reservoirs and their inlets,	1,182	
From streams and miscellaneous sources,	62	
Total from regular water supplies,		1,713
In connection with investigations of new sources of water supply,	173	
With reference to pollution of streams,	126	
With reference to sewage purification at Worcester, Framingham, Marlborough, Gardner, Medfield, etc.,	199	
From sources used for the supply of picnic grounds, etc.,	43	
Miscellaneous,	145	
		686
Total,		2,399

The examination of the microscopic organisms has been continued in the waters which have been examined chemically, as in previous years.

The laboratory for water analysis, which has heretofore been located at the Institute of Technology, was removed at the end of 1896 to rooms set apart for it in the new portion of the State House.

Systems of sewage disposal have been introduced during the year in the towns of Natick and Leicester and at the Westborough Insane Hospital. At the present time there are 11 cities and towns, having an aggregate population of 98,287, in which the purification of the sewage is effected by filtration through beds of gravel or sand, and the sewage of several large public institutions also is disposed of by this method.

References have frequently been made in these reports to the presence of iron in ground waters, and its effect upon the quality of water supplies in which it occurs in excessive quantity. In some cases the quality of the water has been so objectionable as to cause extensive changes in the source of supply, and even an abandonment of the source for this cause, and the problem of improvement of such waters has been the subject of careful investigation by the Board during the past year, and important results have been obtained.

The condition in which the iron exists in water varies in different sources and even in the same source at different times. In one of the towns of the State (Provincetown) it was not feasible to obtain a source of water supply free from iron, and iron has been present in this water in objectionable quantity from the time the supply was first introduced. In this supply iron is found combined with organic matter in such a way that the water is not only objectionable on account of the excess of iron present but on account of the high color of the water.

Water was first introduced into the town in 1893, and, while the quantity of iron at that time was large, it has increased rapidly from year to year, so that at the present time the water contains nearly four times as much as during the first year of its use. Investigations with reference to the purification of this water were begun in the early part of 1896, and have been continued through the year. Experiments upon the filtration of the water through various materials have shown that, by filtration through a filter composed of fine coke, known commercially as coke breeze, practically all of the iron can be removed, and a clear and colorless water obtained which has not been injuriously affected in other respects by the process of filtration. In consequence of the favorable indications furnished by these experiments, the Board has deemed it important to continue the experiments on a larger scale,

and an experimental filter has accordingly been established by the Board at Provincetown. This filter, having a superficial area of one three-hundredth of an acre, was completed and first operated near the end of December, 1896, so that no extended series of analyses showing the results of its operation are as yet available; but the experiments thus far made with this form of filter indicate that a very satisfactory purification of the water will be effected at a moderate cost.

During the summer the attention of the Board was called to the existence of several cases of typhoid fever among the inhabitants of a portion of one of the cities in the State supplied with water from a pond. Upon examination, it appeared that the pond was exposed to pollution from a picnic grove in the vicinity of the water works intake. At about the same time several cases of typhoid fever in another city were traced to a similar resort upon a large pond, which, in this case, was not used as a source of public water supply by a city or town, but visitors were supplied with water for drinking, which was drawn from the pond in the vicinity of the place where sewage entered it from the buildings upon the grounds.

Summer resorts of this kind have become quite numerous in the State, especially in recent years, with the extension of electric railroads; and, in view of the bad sanitary conditions found in the two places referred to, the Board has caused an investigation to be made of a large number of such resorts throughout the State. It is proposed to continue this investigation, and, in cases where the source of water supply and the sanitary conditions are unsatisfactory, to secure their improvement, so far as possible, through owners and the local authorities.

The problem of purification of manufacturing refuse has received special attention, and much valuable information has been obtained from experiments with reference to the purification of sewage of this character, the results of which are given in detail in subsequent pages of this report. Tanneries, paper mills and wool-scouring mills are prominent among the manufacturing establishments which produce large quantities of manufacturing sewage, and a large establishment of either of these kinds may produce as much sewage as a large town, and the organic matter in the sewage of some of these establishments may be several times as great as in an equal volume of domestic sewage. The chemical analyses of manufactur-

ing sewage have shown that in some cases the chemicals used in manufacturing processes are of such a kind as would destroy nitrification if the sewage should be applied to an ordinary sewage filter directly as it comes from the factory. Ordinary methods of chemical precipitation also have little effect upon some kinds of manufacturing sewage. A summary of the results of the investigations made during the year is presented in subsequent pages of this report.

Investigations as to the purification of sewage and water at the Lawrence Experiment Station have been continued as in previous years, and in connection with these investigations a large number of samples of sewage and effluent from existing sewage disposal works has been examined. The results obtained from the experiments with filters which have now been in use for several years are of much value in furnishing information as to the permanency of sewage filters of various materials and the best means of maintaining their permanency, especially in view of the increasing number of sewage-disposal plants in the State and the increasing demand for seweràge facilities.

The Lawrence city filter, established in 1893, continues to operate satisfactorily, and the mortality from typhoid fever in the city of Lawrence is the lowest that has occurred for many years, as indicated by the table on a subsequent page.

ADVICE TO CITIES AND TOWNS.

Under the provisions of chapter 375 of the Acts of 1888, entitled "An Act to protect the purity of inland waters, and to require consultation with the State Board of Health regarding the establishment of systems of water supply, drainage and sewerage," the Board is required

"from time to time to consult with and advise the authorities of cities and towns, or with corporations, firms or individuals either already having or intending to introduce systems of water supply, drainage or sewerage, as to the most appropriate source of supply, the best practicable method of assuring the purity thereof or of disposing of their drainage or sewage, having regard to the present and prospective needs and interests of other cities, towns, corporations, firms or individuals which may be affected

thereby. It shall also from time to time consult with and advise persons or corporations engaged or intending to engage in any manufacturing or other business, drainage or sewage from which may tend to cause the pollution of any inland water, as to the best practicable method of preventing such pollution by the interception, disposal or purification of such drainage or sewage; *provided*, that no person shall be compelled to bear the expense of such consultation or advice, or of experiments made for the purposes of this act. All such authorities, corporations, firms and individuals are hereby required to give notice to said Board of their intentions in the premises, and to submit for its advice outlines of their proposed plans or schemes in relation to water supply and disposal of drainage and sewage; and all petitions to the Legislature for authority to introduce a system of water supply, drainage or sewerage shall be accompanied by a copy of the recommendation and advice of the said Board thereon."

During the year 1896 the Board has given its advice to the following cities, towns, corporations and individuals who have applied for such advice under the provisions of the general act of 1888, or under special acts relating to water supply and sewerage.

Replies were made during the year to applications made from the following sources for advice relative to water supply: Acton, East Acton, Ashland, Braintree (two replies), Cohasset, Franklin, Harvard (Hildreth Bros.), Hatfield, Haverhill (Real Estate Improvement Company), Huntington, Hyde Park Water Company, Kingston, Massachusetts School for the Feeble-minded, Medfield Insane Asylum, Medway, Medway Water Company, Merrimac, Montague (Miller's Falls), Northampton, Pittsfield, Plymouth, Revere Water Company, Sheffield Water Company, Swampscott (Marblehead Water Company) two replies, Uxbridge, Ware, Wellesley, Williamsburg and Woburn.

Replies were made during the year relative to sewerage and sewage disposal, in answer to applications from the following sources: Agawam, Attleborough, Brockton (two replies), Danvers, Danvers Lunatic Hospital, Metropolitan Sewerage Commission (four replies), Natick, Springfield, Stockbridge, Taunton (four replies), Van Choate Electric Company of Foxborough, Westborough Insane Hospital and Whitman.

Replies were also made to the authorities of certain cities and towns, relative to the pollution of streams, as follows: to the water board of Bradford, the water board of Ipswich, the select-

men of Manchester, the board of health of North Adams, the selectmen of Northfield, the water board of Peabody, Mr. U. W. Boyden of Walpole (the Neponset Reservoir), Wrentham (Messrs. Lincoln, Bacon & Co. of Plainville), the Williamstown Water Company.

WATER SUPPLY.

The following is the substance of the action of the Board during the past year, in reply to applications for its advice relating to water supply: —

ACTON. An application was received from the water committee of Acton, Nov. 8, 1895, requesting the advice of the Board relative to a proposed water supply to be taken from the ground in the west part of the town, near the boundary line between Acton and Boxborough. The Board replied to this application as follows: —

BOSTON, March 6, 1896.

The Board has caused an examination of the territory from which it is proposed to take the supply to be made by one of its engineers, and has analyzed samples of water sent in by you from test wells in this territory.

The analyses show that the water was soft and of excellent quality for the purposes of a public water supply at the time the samples were collected. It appears that only a small amount of water had been drawn from the wells at this time, and, though the water was of satisfactory quality, whether it will remain so when water is pumped continuously for a long time cannot be predicted with certainty with present information. Experience with ground-water supplies of the State shows that in some cases, where the water was excellent at first, iron has subsequently appeared in excessive quantities, and the quality of the water has rapidly deteriorated with long-continued pumping, until it has become necessary to provide a new supply. In other cases the waters have remained unchanged after as many as twenty years of continuous pumping, but there is no case which has come to the attention of the Board in which long-continued pumping has improved the quality of the water.

The probable quantity of water to be obtained from an underground source is necessarily somewhat indeterminate. The indications in this case, furnished by an examination of the results obtained from fourteen test wells driven in this locality, are, on the whole, unfavorable to obtaining a large amount of water from the ground here, because the stratum of water-bearing material is in some places very thin and in other places

wholly absent, and because ledge is found in some places at a depth of only 17 or 18 feet beneath the surface.

Under the circumstances, the Board does not advise the construction of works for taking a supply from this locality, unless more extended investigations and a suitable pumping test should indicate beyond reasonable doubt that a sufficient supply of water of satisfactory quality can be obtained from the ground in the locality proposed.

EAST ACTON. An application was received Feb. 18, 1896, from citizens of East Acton, for the advice of the Board relative to the propriety of taking a supply of water from the water works of the town of Concord. The Board replied to this application as follows: —

BOSTON, March 6, 1896.

The town of Concord is supplied from Sandy Pond, in Lincoln, which is also the supply of the town of Lincoln. The act of the Legislature giving these towns the right to supply themselves with water (chapter 188, Acts of 1872) contains the following provision: —

SECT. 11. All the provisions of this act concerning the town of Concord shall apply to the town of Lincoln; and if, in the future, the water of said pond shall prove insufficient for both, the town of Lincoln shall be first supplied.

The capacity of Sandy Pond to supply the towns of Concord and Lincoln is limited, and, while no record of the amount of water consumed in these towns is available, calculations based upon the probable yield of Sandy Pond indicate that the consumption has probably already nearly reached its safe capacity.

The Board is, therefore, of the opinion that the capacity of the Concord water works is likely to prove insufficient for the supply of both Concord and East Acton in the near future, and, under existing circumstances, does not advise East Acton to obtain a supply from the Concord works, as proposed.

ASHLAND. The committee on water supply of Ashland applied to the Board, July 15, 1896, for advice relative to a proposed source of water supply for Ashland. The Board replied to this application as follows: —

BOSTON, Sept. 3, 1896.

The State Board of Health received from you, on July 15, 1896, an application for advice with reference to a proposed source of water supply

for Ashland. Subsequently, test wells were driven by you in the vicinity of the Sudbury River above the town, and in the valley of Cold Spring Brook, and the Board was informed that it was proposed to take the supply from a large well, to be located on the southerly side of the Sudbury River, between it and the Boston & Albany Railroad, about 1,000 feet west of the point where the railroad is crossed by Pleasant Street.

The Board has caused an examination of the proposed source of supply to be made by one of its engineers, and a sample of water from a test well, located at the point at which it is proposed to locate the well for the supply of the town, to be analyzed. The analysis shows that the water coming from the well at this time was of excellent quality for the purposes of a public water supply. It appears that only a small amount of water had been drawn from the well at the time this sample was collected, and it is impossible to predict from this analysis what the character of the water would be if a quantity sufficient for the supply of Ashland should be pumped continuously from the ground here for a long time.

With regard to the quantity of water obtainable from a well in this location, the information obtained by the test thus far made is insufficient to furnish a basis for a satisfactory estimate. The indications furnished by the test wells driven within 200 feet of the location of the proposed well are very unfavorable to obtaining any large quantity of water from the ground in this vicinity, both on account of the character of the soil, which was extremely fine, and on account of the nearness of ledge to the surface of the ground. Moreover, such indications as are furnished by the appearance of the ground about the well are not favorable to the existence of a deep layer of porous gravel of any considerable extent in this vicinity.

Under the circumstances, the Board does not advise the construction of works for taking a supply from this vicinity, unless more extended investigations by means of test wells and a suitable pumping test shall show that water of satisfactory quality is likely to be obtained from the ground in this vicinity in sufficient quantity for the supply of the town.

The Board will, upon application, advise you further with reference to a water supply when you have additional information to present.

BRAINTREE. The water commissioners of Braintree applied to the Board, July 20, 1896, for its advice relative to increasing their water supply by taking water from driven wells in the neighborhood of Little Pond. The Board replied to this application as follows: —

BOSTON, Aug. 6, 1896.

The State Board of Health has considered your application with reference to a proposed additional water supply for Braintree, to be taken from

the ground north of the present filter gallery near the shore of Little Pond, and has caused an examination of the proposed source to be made and a sample of the water from a test well in this locality to be analyzed.

The results of the analysis show that the water is of the same general character as that of the filter gallery. An examination of the conditions about your present filter gallery, taken in connection with the temperature of the water and the character of the analyses shows clearly that the greater portion of the water entering your filter gallery comes by filtration from the pond.

From the information obtainable as to the area of the pond and its watershed, and with certain assumptions as to its storage capacity, it is found that the draft from your present filter gallery in the past two years approached quite closely the probable capacity of the pond in a very dry year. The quantity of water that can be obtained from the ground within the watershed of the pond is no greater than could be drawn from the pond direct, unless, by lowering the ground water near the border of the watershed, water may be induced to flow through the ground toward the filter gallery from beyond the limit of the superficial watershed of the pond. There is no evidence that any large amount of water will flow toward the proposed works from points outside the watershed, and consequently an extension of the collecting system, as proposed, cannot be expected to increase very materially the quantity of ground water obtainable in the vicinity of Little Pond. The construction of additional works along the shore of the pond would make it possible, by lowering the level of the ground water, to draw a somewhat greater quantity of the water stored in the ground over a larger area than at present, and probably to cause a somewhat greater amount of filtration from the pond into the ground.

The watershed of Little Pond contains a population of about 620, or about 1,100 persons per square mile, and, as there are no sewers in this territory, the water is exposed to danger of pollution from this population, so that this pond cannot be regarded as a proper source of water supply if the water is taken directly.

An examination of the results of analyses of samples of water collected from your present filter gallery from time to time shows that there has been a deterioration in the quality of the water, and in the latter part of 1895 the presence of an excessive amount of iron gave evidence that the water of the pond is only partially purified in its passage through the ground. The character of the water varies with the season, the water being better in wet than in dry seasons; but it is probable that, with a continued draft upon the filter gallery, the water will grow worse rather than better in the future.

The conditions are such that the purity of the water of the filter gallery is dependent upon the purity of the water of Little Pond, and, considering the exposure of the latter to pollution from the population upon its watershed, the source cannot be considered a safe one for drinking purposes. Moreover, there is a dense population upon the territory east of the pond, sloping toward the filter gallery, from which a portion of the water of the filter gallery is doubtless derived, and the presence of this population in its vicinity is also a menace to the purity of the water.

In view of all the circumstances, the Board does not advise a further extension of the works for collecting ground water in the vicinity of Little Pond, since neither the quantity obtainable nor the quality is likely to be satisfactory, but advises that you take the whole subject of your future water supply into consideration, with a view to securing a source from which an adequate supply of good water can be obtained to meet the reasonable needs of the town for a considerable time in the future.

It is understood that the town has the right to take water from Great Pond in Randolph and Braintree; but, since a good ground water would doubtless be more satisfactory, before deciding as to a source of supply it is very desirable to determine first whether it is not possible to obtain an adequate supply of ground water from some suitable source.

BRAINTREE. The water commissioners of Braintree again applied to the Board, Aug. 21, 1896, for its advice relative to a "temporary arrangement" for an increase of its water supply. The Board replied to this application as follows: —

BOSTON, Sept. 3, 1896.

The State Board of Health received from you, August 25, an application for advice with reference to obtaining an additional supply of water for the town by putting in tubular wells on the shore of Little Pond, near your present pumping station, in which you state that, pending action by the town with reference to the recommendations contained in the reply of the Board to a previous application, there is an urgent necessity for temporarily supplying more water to the town than can be obtained from the present filter gallery. Accompanying the application was a plan showing the proposed location of test wells along the shore of Little Pond, just north of the present pumping station, the nearest well being distant about 75 feet and the farthest 225 feet from the pumping station. As indicated upon the plan, the wells will be 17 feet from high-water mark in Little Pond.

The Board has carefully considered this scheme, and concludes that it is

probable that a larger supply could be obtained temporarily from the wells and filter gallery together than from the filter gallery alone; but, as it appears that the capacity of this pond and its watershed for supplying water to the town of Braintree in a dry year has already practically been reached, the increase of supply obtained by drawing from the wells would be only temporary, and should a dry year occur, the supply would become exhausted.

With regard to the quality of the water to be obtained from the proposed wells, it may be said that, so far as can be judged from a single analysis, the indications are that it will not differ materially from that of the present filter gallery; and, if the water entering the wells by filtration from the pond should be imperfectly filtered, as there is reason to expect that it may be, the water of the wells will be exposed to danger of pollution from the population upon the watershed of the pond. The sanitary conditions at present existing in the region in which it is proposed to locate the wells are bad, but the conditions could be considerably improved by careful sanitary care of the watershed. Considering the urgent need for an additional supply of water while you are seeking a better source of supply, the Board considers that it is permissible to obtain it in the manner proposed, if the precautions suggested are carefully observed.

COHASSET. The Cohasset Water Company applied to the Board Nov. 14, 1896, for its advice relative to an additional water supply, to be taken from the ground in the neighborhood of a small brook in that town. The Board replied to this application as follows: —

BOSTON, Dec. 5, 1896.

The State Board of Health has considered your application for advice with reference to obtaining an additional supply of water for Cohasset from the ground in the vicinity of a small brook west of Sohier Street, and has caused an examination of the locality to be made by its engineer, and samples of water collected by you from two of the test wells in this locality to be analyzed.

The water of both samples was found to be softer than that furnished by your present wells, but the water from one of the wells (No. 10), which is located a considerable distance south of the railroad and east of the brook, has at some time been polluted and subsequently purified by its passage through the ground. The sample from the other well (No. 7), which probably represents more nearly the average quality of the water of this region, was much softer and of better quality, and in its present state would be a more satisfactory water for domestic purposes than that furnished from your present works.

The information obtained from the tests thus far made is not sufficient to make it possible to predict with accuracy the probable amount of increase in your supply that would be obtained by the use of wells in the localities proposed. From information furnished as to the height of water in the test wells, it appears that the ground water in this vicinity is probably already influenced by the pumping from your present wells. By lowering the ground water here by means of additional wells, it would be possible to draw a somewhat greater quantity of the water stored in the ground, and to cause the water to percolate toward the wells from a larger area than at present. It is possible, also, that water from the brook filters into the ground to some extent under present conditions, and filtration from this source might be increased somewhat by lowering the level of the ground water in the vicinity of the brook; but it does not seem likely that there will be any considerable increase in the quantity of water that will be obtained from this source. It appears, from the results obtained from the test wells, that ledge is found nearer the surface at this place than in your present wells, and that the gravel stratum in most of the wells is quite thin. These indications are not favorable to a large yield from the proposed source, and are not conclusive as to whether the additional supply obtainable in this place will be sufficient to warrant the expense of connecting it with your present works, even though the cost would be small.

It is desirable, therefore, before incurring the expense of constructing permanent works in this locality, that you cause a pumping test to be made by pumping continuously from a number of wells with a steam pump for a period of at least two weeks, with a view to obtaining some more definite evidence as to the probable yield from this source. The capacity of your present works is insufficient for the present needs of the town in the summer season, and it is very desirable that in constructing additional works you secure a supply that will be adequate for present needs in a dry season and sufficient to meet the reasonable needs of the town for a considerable time in the future. Unless, therefore, you find upon further investigation that the quantity of water which these wells will furnish will be a material addition to your present supply and furnish a sufficient quantity of water to meet the needs of the town in connection with your present works for several years, it will probably be more economical to secure in the beginning a supply from some adequate source.

FRANKLIN. The selectmen of Franklin applied to the Board, Aug. 1, 1896, requesting the Board "to investigate the sources of the public water supply of Franklin, and report their finding." The request was made on account of a communication from one of

the citizens of Franklin, asking for an investigation as to the quality of the public water supply. The Board replied to this application as follows: —

BOSTON, Oct. 1, 1896.

The Board has caused an examination of the sources of supply to be made and samples of the water to be analyzed. The sources in use at the time of examination were two wells, located on the easterly side of Mine Brook, distant about 50 feet from high-water mark in the brook, and a pond, known as Beaver Pond, on the westerly side of Mine Brook.

There is a large population in the village of Franklin upon the territory from which a portion of the water which enters the wells is evidently derived, but no buildings are found within 700 feet of the wells at the present time. Analyses of the water show the presence of some of the mineral matters due to the sewage entering the ground in the populated portion of the territory draining toward the wells. It is probable, also, that a portion of the water is derived by filtration from Mine Brook, a highly polluted stream; but the analyses show that such polluted waters as may have mingled with the ground water entering the wells have been thoroughly purified in their passage through the ground, and at the present time the water is safe for drinking. The indications are that the population will increase upon the territory sloping toward the wells, and in that case the quality of the water will tend to deteriorate; but if no houses are constructed nearer the wells than at present, and if the sewage is removed from the district, further deterioration can probably be arrested.

As already stated, it is probable that a portion of the water entering the wells is derived from Mine Brook by filtration through the ground. The experience with wells in similar situations has sometimes been that after a longer or shorter period of use the quality of the water deteriorates, owing to imperfect filtration of the water passing through the ground from the neighboring pond or stream to the well; and, while there is no evidence that any of the water entering the wells of the Franklin Water Company up to the present time has been imperfectly filtered, it is very desirable that the discharge of domestic or manufacturing sewage into Mine Brook or its tributaries above the wells be prevented.

The analyses of the water of Beaver Brook show that it is highly colored, and contains at times a large amount of organic matter in the form of microscopical organisms of a kind which have been known to produce disagreeable tastes and odors in the water of many other ponds and reservoirs in the State. These conditions affect the appearance and taste of the water, but with our present knowledge are not regarded as dangerous to the health of those drinking it. The watershed of the pond contains so

small a population that the danger of the pollution of the water from sewage discharged upon the ground within its watershed is very slight. From an examination of the pond and its surroundings, it appears that between the pond and Mine Brook there is an area of low and swampy land which is apparently flooded at times of high water in the brook, and the outlet from the pond to the brook passes through this low land. It is not feasible to determine, from the limited examination which the Board is able to make, whether it is possible for the water from the brook under certain conditions to enter the pond. If brook water should enter the pond, it would enter on the side where the intake is located, and there would be great danger that this polluted brook water might be drawn for the supply of the town. In order to determine whether this is possible, a careful survey and investigation will be necessary, and the Board advises that such an investigation be made. If it should be found that brook water can, under present conditions, enter the pond, it may probably be kept out by constructing a dam, and, if necessary, a dike, at the outlet of the pond and along its easterly shore; but if these works should be found necessary, it would be well to consider whether it may not be possible to obtain a more satisfactory supply than the pond furnishes, by constructing a well at some suitable locality in the vicinity of the town where a satisfactory supply of ground water can be obtained.

It is possible that a portion of the complaint as to the quality of the water supplied to the town may be due to the growth of microscopical organisms in the open tank. Trouble from this cause could be avoided by covering the tank, and it is advisable that this be done if the use of ground water is to be continued.

HARVARD. Messrs. Hildreth Bros. of Harvard applied to the Board, June 26, 1896, for advice relative to a proposed water supply for a factory and a few dwelling-houses in that town, to be taken from a well north of the common. The Board replied to this application as follows: —

BOSTON, Aug. 6, 1896.

The analyses show that the water is hard and has at some time been polluted, but subsequently well purified by its passage through the ground. In its present condition the water is suitable for drinking and other domestic purposes, though the hardness will probably make it somewhat unsatisfactory for washing and for use in boilers.

The information furnished by you indicates that the quantity of water which the source of supply will yield is limited, but is probably sufficient for the supply of the factory and houses mentioned in your application.

It is suggested that, should an additional supply be found necessary in the future, better results can probably be obtained at less expense by sinking wells at some place where there is a considerable area and depth of gravelly soil, and avoiding the sinking of wells in rock, if a suitable area can be found where the water will not be exposed to danger of pollution.

HATFIELD. The selectmen of Hatfield applied to the Board, May 7, 1896, for its advice relative to taking the water of Field's Brook as a supply for a portion of the town of Hatfield. The Board replied to this application as follows: —

BOSTON, June 4, 1896.

The analysis shows that the water is soft, practically colorless and of excellent quality for the purposes of a public water supply. Its quality would be likely to be more satisfactory to consumers if the water is stored in a reservoir from which light is excluded than if stored in an open reservoir.

The information available as to the quantity of water that the proposed source will yield in the drier portion of a dry year is not sufficient to enable the Board to advise you definitely as to whether the yield of the brook will be sufficient for the supply of the village at all times; and, considering the desirability of obtaining an ample supply and one which can be furnished under sufficient pressure for fire purposes, the Board does not at present advise the construction of works for taking water from this source, but advises a further investigation, to determine whether a more ample supply of equally good water may not be obtained at a reasonable cost, and at such an elevation above the village that the pressure in the pipes will be sufficient for use in the extinguishment of fires.

HAVERHILL (the Real Estate Improvement Company). This corporation applied to the Board, July 23, 1896, for advice with reference to the use of water from a well situated beneath a building in Haverhill, for domestic purposes. The Board replied to this application as follows: —

BOSTON, Sept. 3, 1896.

The State Board of Health has considered your application for advice with reference to the use for domestic purposes of water drawn from a well beneath a building in the densely populated portion of Haverhill, and has caused an examination of the premises to be made by one of its engineers and samples of the water to be analyzed.

It appears that the quantity of water furnished by the well is insufficient for the supply of the building, and to insure a full supply at all times there is an automatic connection with the city water works by means of which the building is partially supplied with city water. For this reason it is difficult to obtain representative samples of the well water. The analyses show, however, that the quality of the water is objectionable on account of its extreme hardness, the hardness being about ten times as great as that of the chief sources of the city's water supply; and it is evident from the analyses that the water entering the well has been previously polluted by sewage and subsequently largely purified by its passage through the ground, but the indications are that the purification is not perfect at all times.

Considering the location of the well and the character of the analyses, the Board does not consider this well a safe source of water supply for domestic purposes, and advises that its use be discontinued.

HUNTINGTON. The Board received an application from citizens of Huntington, Dec. 23, 1895, for the advice of the Board relative to a proposed increase of their water supply by taking the water of certain springs west of the village. The Board replied to this application as follows: —

BOSTON, March 6, 1896.

The State Board of Health received from you Dec. 23, 1895, an application with reference to a proposed additional water supply for the village of Huntington, in which you state that you have at present a source of supply sufficient for about forty families, but that, having in view the extension of the works, for which your present source will not furnish a sufficient quantity of water, you wish to increase your supply by obtaining water from a group of springs west of the village. In a communication accompanying the application it is stated that an application may be made to the Legislature for a charter.

The Board has caused an examination of the proposed source of supply to be made and a sample of the water to be analyzed. The analysis indicates that the water is excellent for the purposes of a domestic water supply.

The quantity of water which the proposed source would furnish cannot be estimated with accuracy with present information, but it is likely in dry seasons to be less than the yield of your present source, which was found inadequate at times during the past summer for the supply of forty families.

It is the tendency in all communities, even in very small ones, into which a public water supply has been introduced, for the consumption of water to increase rapidly for several years, and it is improbable that your present and proposed works together would supply as much water as ought to be provided for a village the size of Huntington.

The Board would, therefore, advise that you have a thorough investigation made, with a view to determining the best source for the permanent supply of the village; and it would probably be a measure of true economy to secure at once a source which will furnish an adequate supply of good water, rather than to spend money upon a source that is likely to prove inadequate in a very few years, if the pipe system in the village is extended to any considerable extent.

Should you decide to make further investigations with reference to obtaining a supply from a larger source, the Board will advise you concerning it when you shall have submitted the results of your investigations.

HYDE PARK. The Hyde Park Water Company applied to the Board, Aug. 24, 1896, for its advice relative to taking an additional supply of water from the neighborhood of Mother Brook, between Hyde Park and East Dedham. The Board replied to this application as follows: —

BOSTON, Dec. 3, 1896.

The State Board of Health received from you, on August 24, an application requesting advice as to obtaining an additional water supply for Hyde Park from the region in the vicinity of Mother Brook between Hyde Park and East Dedham, through which the metropolitan sewer has recently been constructed. Subsequently you made more definite investigations in this territory, by driving test wells on both sides of the brook, about 1,000 feet below the lower dam of the Merchants' Woolen Mill in Dedham, near the boundary line between Dedham and Hyde Park, and a plan showing the location of these wells has been submitted.

The Board has caused an examination of this territory to be made by one of its engineers, and samples of the water from two of the test wells, one located on the northerly and the other on the southerly side of the brook, to be analyzed.

The sample from the well on the northerly side of the brook, which was collected before any considerable quantity of water had been pumped, was found to be soft and of good quality, though there were indications that the water had previously been polluted to a slight degree by sewage and subsequently purified by its passage through the ground.

From one of the wells on the southerly side of the brook two samples

were collected for analysis, one after pumping for about eight hours and the other after pumping for about two days. These analyses showed in a much greater degree than the first the effect of previous pollution due to the presence of population upon the territory from which the water is derived, but the analyses also show that the water had been very thoroughly purified by its passage through the ground.

With regard to the probable quantity of water to be obtained from this source, the information at present available is not sufficient to enable a definite prediction to be made. The examinations thus far made indicate that water can be drawn from the test wells with much freedom, and the character of the soil south and west of the wells, judging from surface indications, is favorable to a large yield of water from the ground.

The situation of the test wells is such that it seems probable that, when a continuous draft is made upon the ground, water will be drawn from territory in Dedham and Hyde Park where there is a large population, and the water will become harder than it is at present, and it may be less perfectly purified.

Another source of danger to the quality of the water is that the water of Mother Brook, which receives a considerable quantity of domestic and manufacturing sewage from the territory through which it flows, may find its way through the ground to the wells without being thoroughly purified by filtration. It is impracticable to predict whether the water taken from the ground in this region would deteriorate in quality from either cause to such a degree as to make it unsafe for use for the next two years; but, considering the necessity of supplementing your present supply and the desirability of obtaining a water of better quality than that at present supplied to Hyde Park and Milton, for use until such time as the metropolitan water supply shall be available, the Board would advise that this location be adopted as a temporary source of supply, but that the quality of the water be carefully observed by means of frequent analyses, in order that any serious deterioration may be discovered. The wells should be located as far as practicable from dwelling-houses and from Mother Brook.

KINGSTON. The water board of Kingston applied to the Board, April 27, 1896, for its advice relative to increasing the public water supply by taking water from the ground in the valley of Furnace Brook in that town. The Board replied to this application as follows: —

BOSTON, July 3, 1896.

The State Board of Health has considered your application for advice with reference to a proposed water supply for the town of Kingston, to be

taken from the ground in the valley of Furnace Brook, so-called, and has caused an examination of the proposed source to be made by one of its engineers, and samples of water from test wells in the region in which it is proposed to locate the works to be analyzed.

Judging from tests which you have made by driving wells in the valley of the brook about 600 feet below the tack factory, and pumping from them, the conditions are favorable, both with regard to the porosity of the material and the freedom with which water could be pumped from the test wells, to obtaining a large quantity of water from the ground at this place.

The water of the test wells, as shown by several analyses, is colorless, soft, and otherwise of excellent quality for the purposes of a public water supply. The quantity of iron present in the water was insignificant, and showed no tendency to increase while pumping for a period of ten days; but there are indications that the water filtering past the dam at the tack factory is strongly impregnated with iron, and in constructing a system of wells for collecting ground water in this valley it will be necessary to avoid locating any of the wells in the vicinity of this dam.

The surface of the ground about the test wells is at an elevation several feet above your present pumping station, and it is understood that you propose to lay a pipe to convey the water from the proposed source to the pumping station by gravity; but if sufficient water is not furnished in this way it is expected to use the pipe as a suction main. It is probably not practicable, with so long a suction main, to reduce materially the level of the water in the ground about the wells; and, as the area from which water can safely be drawn is limited by the proximity of the dam above the wells and by the character of the material found beneath the ground a short distance down stream from the wells, which is said to be very fine, there is some uncertainty as to whether a sufficient quantity of water for the supply of the town at all times can be obtained from this source in the manner proposed.

It is very desirable, in constructing works for obtaining a new supply of water, that you secure an ample quantity for the needs of the town at present and for a reasonable time in the future; and the Board advises that, before finally locating your wells and laying the pipe to the pumping station, you ascertain whether the supply can be increased, if necessary, by extending the collecting system farther up the valley of Furnace Brook.

The Board is informed that there are several long lines of lead pipe in use for distributing water in the town, notwithstanding the fact that the use of these pipes for the distribution of water seriously injured the health of many citizens of the town last year, causing this Board to recommend the immediate removal of all lead pipes in the town. The Board again

urges the town to proceed at once to remove all the lead pipe now in use in the town, whether as mains or service pipes.

MASSACHUSETTS SCHOOL FOR THE FEEBLE-MINDED. The trustees of the Massachusetts School for the Feeble-minded applied to the Board, May 21, 1896, for its advice relative to the propriety of covering their water reservoir. The Board replied to this application as follows: —

BOSTON, July 3, 1896.

The State Board of Health has considered your application for advice as to the necessity or advisability of covering the distributing reservoir of your water-supply system, in which you state that your supply is obtained by pumping from the works of the city of Waltham, and that the water is often offensive to sight and smell, but that it has not apparently been any better or worse for passing through your reservoir.

The water supply of the city of Waltham is taken from a covered filter basin and well near the Charles River, above the city, and the water at the source of supply is free from taste and odor and from vegetable organisms, and is a very satisfactory water for domestic use. The water is supplied to the city by pumping, and an open reservoir is used in connection with the distributing system. The exposure of the water to light in the reservoir is the cause of the presence in the water of large numbers of microscopical organisms at nearly all times, which impart to the water a disagreeable taste and odor.

The effect of exposing ground water to light in an open distributing reservoir upon the quality of the water is well known, and the use of the reservoir is avoided, so far as practicable, by pumping as nearly as possible at the same rate as the consumption. It is, therefore, probable that most of the supply that is pumped to your distributing reservoir, especially during the summer season, is water which comes from the well or filter basin, and has not passed through the city distributing reservoir. The storage of this water in a reservoir where it is exposed to light would be favorable to the growth of microscopical organisms, and the quality of the water would deteriorate in consequence.

In view of the circumstances, therefore, it is desirable that you cover your reservoir in such a manner as to keep the water wholly from exposure to the light. There will, of course, still be danger that a portion of the water pumped to your reservoir will come from the Waltham distributing reservoir, and possibly be affected by taste and odor; but if your reservoir is covered so as to exclude the light, the conditions will be unfavorable to a continuation of the development of microscopical organisms that may enter it.

MEDFIELD INSANE ASYLUM. The trustees of the Medfield Insane Asylum applied to the Board, July 1, 1896, for its advice relative to a proposed additional water supply for the asylum, to be taken either from driven wells near the present supply or from Farm Pond in Sherborn. The Board replied to this application as follows: —

BOSTON, Oct. 1, 1896.

The Board has caused an examination of both of these sources to be made by one of its engineers, and has had samples of the water analyzed. It was originally proposed to draw the supply for this institution from the ground, on the right or easterly bank of the Charles River, near the line between Dover and Medfield, and twenty tubular wells were sunk in this locality. The quality of the water furnished by these wells is excellent, but the quantity has been found to be wholly inadequate for the needs of the asylum, and the supply for purposes other than drinking has been drawn from the Charles River. Judging from information furnished by your engineer as to the character of the material found beneath the surface in this vicinity, it appears that there are in places deposits of gravel from which ground water can be drawn freely, while in other places the material is so fine that it will yield but little water. The conditions, on the whole, are such that it is not probable that a sufficient quantity of water for the asylum could be obtained by driving additional wells in the vicinity of the present works.

Farm Pond is situated at such an elevation that its water can be drawn to your present pumping station by gravity. The water of Farm Pond has been examined several times during the past summer, by means of chemical and microscopical analyses, and has been found to be very soft, nearly colorless, and otherwise of excellent quality for a domestic water supply. The watershed is free from dwelling-houses, and the source is naturally an excellent one for water-supply purposes. On one side of the pond there is a grove used by picnic parties in summer, and care will be necessary to prevent danger of pollution of the water from this cause. The situation of the pond, not far from the village of Sherborn, is such that it may be found to be the most appropriate source of supply for this village in the future; but the yield of the pond will be sufficient both for the asylum and for the town of Sherborn, unless the population in either shall increase to a much greater extent than is to be expected at present.

The Board therefore concludes that Farm Pond is an appropriate source of additional water supply for the Medfield Insane Asylum.

MEDWAY. The water supply committee of Medway applied to the Board, May 23, 1896, for its advice relative to the introduction of a public water supply, certain alternative sources being specified in the application. The Board replied to this application as follows: —

BOSTON, July 3, 1896.

The State Board of Health received from you, on May 25, an application for advice with reference to a proposed water supply for the town, in which you mention three proposed sources of supply, two of which are in the valley of Chicken Brook and the third on the north side of Main Street, near Holliston Street.

The Board has caused an examination of the proposed sources to be made by one of its engineers, and samples of water from a spring and test well in the valley of Chicken Brook to be analyzed. The analyses show that the water is of suitable quality for domestic purposes, but it does not appear probable that a supply of ground water sufficient for the supply of the town of Medway can be obtained from the valley of this brook in the vicinity of either of the points indicated by you.

With reference to the third source, it is understood that your committee has already concluded that the probable quantity of water that could be obtained from it would be entirely inadequate for the supply of the town.

The Board has already, on a previous occasion, considered the question of a water supply from these sources and from certain other sources in the town, in response to an application from H. V. Mitchell and others, who were about to form a water company; and a copy of the reply of the Board, which was dated March 1, 1892, is enclosed.

The Medway Water Company submitted an application to this Board, in July of last year, for advice with reference to a water supply to be taken from the ground in the easterly part of the town, and have continued their investigations during the earlier portion of the present year. In response to their application, the Board has recently advised the Medway Water Company with reference to their proposed water supply, and a copy of this communication is also enclosed.

MEDWAY. The Medway Water Company applied to the Board, July 19, 1895, for its advice relative to taking a public water supply from the ground on the left or northerly bank of the Charles River in the east part of the town. The Board replied to this application as follows: —

BOSTON, July 3, 1896.

The Board caused an examination of the proposed source of supply to be made, and samples of water from the test wells located in the vicinity of the corner of Walker and Village streets to be analyzed. The results of these analyses showed that the water had previously been polluted and subsequently purified to a large extent by its passage through the ground; but iron was present in such quantities in some of the samples as to indicate that the water would be affected by the presence of an excessive amount of this ingredient, should a large quantity of water, such as would be needed for the supply of the town of Medway, be drawn continuously from the ground in this vicinity.

In view of the unfavorable character of the water obtained from these test wells, you requested that the Board postpone the consideration of this matter until further investigations could be made; and in the spring of the present year a second group of test wells was put in by you in territory on the opposite side of the river, and about 500 feet farther down stream. These wells are three in number, and are situated about 60 feet from the river, where the latter makes a sharp bend known as the "ox-bow." The Board has caused an examination of this locality also to be made, and has found that the conditions, as regards the porosity of the soil, are favorable to obtaining water freely from wells here, and the territory on both sides of the river appears to be of a porous character, judging from surface indications; but with the information at present available it is not feasible to tell whether or not a sufficient supply of water for the town can be obtained from the ground in this vicinity.

Samples of water have been collected from each of the three test wells on two occasions, and the results show in general that the water has at some time been polluted but subsequently purified by its passage through the ground. The quantity of iron in all of the samples was so small as not to affect the quality of the water, but there was a marked increase in the quantity of iron found in the second set of samples, which were collected after pumping for about ten hours daily for several days with a hand pump. The quality of the water in other respects improved somewhat with pumping.

The changes that took place in the character of the water while pumping only a comparatively small amount from the wells make it impossible to predict what the probable character of the water would be, after pumping continuously for a long time a quantity such as would be needed for the supply of Medway. The location of the proposed wells, in the vicinity of Charles River, a stream which receives considerable sewage pollution from the factories and villages along its banks above this point, makes it essential that any water that may enter the wells from the

river shall be thoroughly purified by filtration for a long distance through the ground.

In view of all the circumstances, the Board does not advise the construction of works for taking a supply of water from the ground in the vicinity of the present test wells until you have made further tests by driving wells and pumping from them continuously, at as great a rate, at least, as would be necessary for the supply of a town like Medway, and for a sufficient time to determine whether this source can be depended upon to furnish water of satisfactory quality for drinking purposes, and in sufficient quantity for the supply of the town.

It is very desirable, in putting in additional wells, that they be placed at a much greater distance from the river than the present test wells.

The Board will, upon application, give you further advice in this matter when you have the results of further investigations to present.

MERRIMAC. The water supply committee of Merrimac applied to the Board for its advice relative to a water supply for that town, suggesting certain sources for examination. The Board replied to this application as follows: —

BOSTON, Dec. 3, 1896.

The State Board of Health has considered your application with reference to a proposed water supply for the town of Merrimac, and has caused an examination of the sources mentioned in your application to be made by its engineer, and samples of the waters to be analyzed.

The first source mentioned is Cobbler's Brook, which you propose to use either by taking water from the ground, about half a mile above the railroad station and near the old Tukesbury dam, or by taking water from a storage reservoir, to be formed by constructing a dam across the valley near the old Tukesbury dam, or by both methods.

In this locality you have made tests of the ground by means of tubular wells, a portion of the wells being located close to the old dam, and the others about 400 feet farther down the stream. The results of these examinations do not show the presence of porous material of sufficient depth and extent to furnish a reasonable expectation of obtaining any considerable quantity of water from the ground. An analysis of a sample of water collected by you from the test well from which water could be pumped with the most freedom, shows that it contains so large a quantity of iron that the water would be objectionable for many domestic purposes.

It is probable that, by constructing a storage reservoir of sufficient size at the place proposed, enough water could be obtained from the brook for the supply of the town; but the analyses of samples of water from the

brook at this point show that the water is highly colored and contains a large amount of organic matter, so that it would be an unsatisfactory water for domestic uses in its present state, and it is unlikely that its quality would be materially improved by storage in a reservoir of the size that would be needed for the supply of the town of Merrimac.

The next source mentioned in your application is Lake Attitash, or Kimball's Pond, water to be taken either directly from the pond or from the ground near the pond, or by both methods.

The pond is capable of supplying a much greater quantity of water than would be needed by the town of Merrimac. A limited number of analyses of the water, made in the months of May, September and October, show that it is soft, but that its quality is variable. The water has at times a high color and contains a somewhat large amount of organic matter, as shown by these analyses; and the microscopical examinations show the presence of some minute vegetable organisms, which are often found in waters which give trouble from bad tastes and odors. The pond is, moreover, exposed to danger of pollution from the summer cottages along its shores, and in its present condition cannot be considered a desirable or safe source of public water supply.

Test wells have been driven by you in two localities in the vicinity of the pond, one near the southerly shore and the other near the westerly shore south of Back River. The results obtained from tests near the southerly shore of the pond were unfavorable, since no deep stratum of coarse sand or gravel was found from which water could be obtained with freedom. The tests made on the westerly shore of the pond were somewhat more favorable, and a sample of water collected by you from one of the wells was found to be colorless, soft, and otherwise excellent for the purposes of a water supply; but ledge was found at no great distance beneath the surface, and, judging from the results of these tests, the conditions are not favorable for obtaining a sufficient quantity of water for the town in this locality.

The next source mentioned is "The Plains," so-called, a level tract of land extending from near the southerly end of Kimball's Pond toward the Merrimac River. From information obtained from a single test well as to the character of the material beneath the surface of the Plains, it appears probable that the material is too fine to yield water freely in any considerable quantity; and, judging from the topography of the region, the area from which water would be contributed to the wells in this territory would be too small to furnish at all times the quantity of water that would be required by the town.

The last source mentioned in your application is the Back River watershed, from which you propose to take water either from the ground just

below and not far from Sargent's Millpond, including the water of Sargent's Spring, or directly from the brook by constructing a storage reservoir thereon, or by both methods.

It appears that three test wells have been driven in this valley, at points within a distance of about a quarter of a mile below Sargent's Pond, in two of which the material was found to be so compact that no water could be obtained, and ledge was found within a few feet of the surface. In one of the wells a coarse stratum of gravel was found, from 6 to 14 feet beneath the surface, from which water could be drawn with considerable freedom, and a sample of water from this well was collected by you for analysis. The results showed the presence of so large a quantity of iron in the water as to make it very objectionable for most domestic uses.

Sargent's Spring and the springs in its vicinity, according to measurements furnished by your engineer, would not, alone, furnish a sufficient quantity of water for the town, though the quality, judging from an analysis of the water of one of these springs, would probably be good.

Analyses of the water of Back River show that it is very highly colored and much poorer in quality than the water of Cobbler's Brook, so that its use for water-supply purposes would be even more objectionable than the use of water from Cobbler's Brook.

From the investigations thus far made, it does not appear that any of the sources mentioned in the application are likely to furnish a sufficient quantity of water of satisfactory quality for the supply of the town of Merrimac.

In general, a supply of water taken from the ground is much to be preferred to one taken from a stream or other surface-water source, because the water is colorless and free from unpleasant tastes and odors; and the Board would advise that you continue your investigations, with a view to obtaining a supply of good water from the ground.

While the investigations made in the vicinity of Kimball's Pond were unfavorable to obtaining a sufficient supply of water from the ground, they were not extensive enough to enable the Board to conclude that a sufficient supply may not be obtained in this region. Judging from surface indications, coarse gravel is likely to be found beneath the surface along the northerly side of Kimball's Pond, between its outlet and Back River; and, while this territory is outside the limits of Merrimac, it is desirable that an investigation be made here, to see whether it may not be possible to obtain a supply of water from the ground in this locality. It also seems desirable that a further investigation be made along the shore of the pond, south of Back River.

The Board will, upon application, give you further advice in this matter when you have the results of additional investigations to present.

MONTAGUE (MILLER'S FALLS). The State Board of Health received an application from the water supply committee of Miller's Falls, Dec. 9, 1895, for the advice of the Board relative to certain proposed sources of water supply for that village, at the same time suggesting Osgood Brook and Lake Pleasant as alternative sources. The Board replied to this application as follows: —

BOSTON, Feb. 6, 1896.

The State Board of Health has considered your application with reference to a proposed water supply for Miller's Falls, in which you state that the sources under consideration are Osgood Brook, so-called, and Lake Pleasant, the present source of supply of Turner's Falls, and ask the advice of the Board as to which of these sources will furnish the best water, and as to whether Osgood Brook will furnish enough water, if taken in the vicinity of Lyon's mill, to supply the present and prospective population of the village in the driest time in a dry year, and for any other information which will assist you in the selection of a water supply for the village.

The Board has caused an examination of Osgood Brook to be made, and samples of the water of the brook in the vicinity of Lyon's mill and of the water of Ruggles Pond, situated upon the brook above Lyon's mill, to be analyzed. The samples were collected from each source December 8 and 19. The water of the pond and brook on the first date had a very high color; on the second date, the color of the water of the pond remained practically the same, but the color of the water of the brook was considerably less, a condition which might have been caused by melting snow-water entering the brook below the pond.

It is difficult to judge, from analyses made at this season of the year, what the character of the water may be at other times; but, judging from the information at present available as to the character of this pond and from the results of the analyses, the indications are that the water of this pond and consequently of the brook below is likely to be unsatisfactory for domestic purposes.

While it might be possible, either by making improvements in Ruggles Pond and its vicinity by removing the vegetable matter and raising the dam or by draining the pond and the swamps above it, to improve the quality of the water of Osgood Brook, the cost to the village of obtaining a water supply of satisfactory quality in this way would probably exceed the cost of a supply from Lake Pleasant.

With reference to the probable quantity of water that Osgood Brook would furnish in a very dry season, without the use of the storage capacity of Ruggles Pond, no definite advice can be given with present informa-

tion. Should the flow per square mile be as small as has been found to be the case with some brooks of similar character, the yield would not probably be sufficient for the village at all times; while, if the flow is as well maintained in the drier portion of a dry summer as it is in the case of many other brooks, the quantity would be ample. This matter could only be determined by careful gaugings of the flow of the brook in the drier portion of a dry season.

In view of all the circumstances, the Board is of the opinion that Lake Pleasant would prove a more satisfactory source of supply than Osgood Brook in its present state, and is the more appropriate supply for the village of Miller's Falls.

NORTHAMPTON. An application was received from the water board of Northampton, Feb. 3, 1896, for the advice of the State Board of Health relative to increasing the water supply of the city by taking the water of Ashfield or Bradford Brook, a tributary of Mill River. The Board replied to this application as follows: —

BOSTON, March 6, 1896.

The State Board of Health received from you, Jan. 25, 1896, an application relative to the use of Mill River and its tributaries as a source of water supply for Northampton. Regarding this source of supply and the proposed method of utilizing the water from it, you make the following statement: —

"We ask for the State right to use Mill River and its tributaries for a water supply for Northampton, Mass.

"We do not expect to use the whole system at present, but a tributary of Mill River, called the East Branch of Ashfield or Bradford Brook, in Williamsburg, which is the site of an old reservoir that went out in May, 1874, causing the Mill River flood, and which has not been rebuilt. The land flowed would be about 108 acres, the depth at dam about 47 feet, the average depth about 20 feet, the capacity about ¾ billion gallons. It is said to have filled four times in ordinary years.

"Under the circumstances, perhaps it would be considered necessary for you to examine only this branch of Mill River.

"The surrounding country is uninhabited, mountainous and mostly wooded, with no highways near, and no danger of pollution either present or in prospect.

"The bed of the reservoir site is covered with a growth of wood twenty-two years old. The soil is gravelly, with no swamps so far as we know. The quality of water is excellent.

"We propose to pipe from the dam about 4 miles to where the water will flow in an open stream to our new or middle reservoir, about 2 miles."

The Board has caused an examination of the East Branch of Ashfield or Bradford Brook to be made, and a sample of water collected near the site of the former reservoir to be analyzed. The analysis shows that the water is slightly colored, but that it is quite soft, and otherwise of satisfactory quality for the purposes of a domestic water supply; and, while it is difficult to judge from a single analysis at this season of the year what the quality of the water may be at other seasons, there is little reason to expect that it would be very different; and, if the water is stored in a reservoir properly prepared for the purpose by the removal of all the soil and vegetable matter from the area to be flowed, its quality should not deteriorate.

The quantity of water which this source would yield with a reservoir of the size proposed would be sufficient, in connection with present sources, for a population several times as great as is now contained in Northampton.

An estimate of the capacity of the present sources of supply of Northampton, based upon the area of the watershed, as measured from the topographical map of the State, and the capacity of the existing storage reservoirs upon this watershed, as given in the annual reports of your board, indicates that, if the consumption of water per capita in Northampton is no larger than in other cities where records of the consumption of water are kept, the capacity of your present sources is sufficient for the supply of the city for several years, and there is no immediate need of a new supply on account of the quantity of water.

The quality of the water, while affected somewhat by contact with vegetable matter in swamps, which gives it at times considerable color, is satisfactory, excepting that the water of the reservoir recently built was affected by a disagreeable taste and odor during the summer of 1895. This may have been caused by the flooding of a swampy area adjacent to the reservoir, in consequence of the use of the flashboards upon the dam. By avoiding this condition in the future, the quality of the water of this reservoir is likely to be more satisfactory.

If the storage capacity upon the watershed could be doubled, a large increase in the capacity of the works would be made, and the need of an additional supply from another watershed would be postponed for many years. Moreover, if a site can be found where a storage reservoir of considerable depth can be constructed, and if the reservoir is properly prepared for the reception and storage of water by the thorough removal of the soil and vegetable matter from its bottom and sides, water of satisfactory quality should be obtained. It is possible that the further improve-

ment in the quality of the water could be made by draining the swamps upon the watershed, where necessary. The information at present available, however, is not sufficient to enable the Board to determine whether it is feasible to increase further the reservoir capacity upon the watershed, and it would be very difficult to make a satisfactory investigation with reference to this matter at this season of the year.

Under the circumstances, the Board would advise that, before proceeding to take an additional supply from the valley of Mill River, as proposed in your application, you cause an investigation of the watershed of Roberts' Meadow Brook to be made, to determine the feasibility of increasing the storage capacity thereon, and the probable cost of increasing the supply of Northampton in this way, as compared with the cost of obtaining an additional supply from the valley of Mill River.

In this connection the Board would also suggest that you cause an investigation to be made as to the feasibility of obtaining an additional supply in connection with your present works, by diverting into the watershed of Roberts' Meadow Brook by gravity the waters of the upper portion of the North Branch of the Manhan River, about 3½ miles above the village of Loudville, and as to the probable quantity and quality of water to be obtained from this source, and its cost as compared with the other schemes.

The Board will, upon application, advise you further in this matter when you have additional information to present.

PITTSFIELD. The board of public works of Pittsfield applied to the State Board of Health, Nov. 18, 1895, for its advice with reference to increasing the water supply of the city by taking the waters of certain brooks in neighboring towns. The board replied to this application as follows: —

BOSTON, Jan. 16, 1896.

On Nov. 18, 1895, the State Board of Health received from you an application for advice with reference to your proposed plans for increasing the water supply of Pittsfield, as follows: —

"The city of Pittsfield, represented by its board of public works, desires the advice of the State Board of Health upon its plans for increasing its water supply in the following manner: —

"Taking and appropriating the waters of Sachem and Hollow brooks in Lanesborough and in Hancock, if their watershed extends into the town of Hancock, and bringing them into the northern part of our water system by means of the construction of a dam or dams at a suitable elevation to cause these waters to flow into our system by gravity; the taking and

appropriating of the waters of Smith and May brooks in the city of Pittsfield and the town of Hancock, and bringing them into the western portion of our water system in the same manner; raising the dam at Ashley Lake, our present storage reservoir, so as to increase its storage capacity."

Subsequently a report of your engineer was submitted, containing the results of his investigations with reference to an additional water supply for the city, with data as to the consumption of water and the flow of many streams in the vicinity, including those at present used for the supply of the city and those proposed as sources of additional supply.

The Board has caused an examination of the proposed sources of supply to be made by one of its engineers, and samples of the water to be analyzed.

The results of analyses of samples of water from each of the brooks mentioned in your application, collected by you on Aug. 12, 1895, and of samples collected on Nov. 27, 1895, after heavy rains, indicate that the water of Smith and May brooks is of about the same character as that of Sackett, Ashley and Mill brooks, three of your present sources of supply. The waters of Sachem and Hollow brooks, however, while of much the same quality in most respects, are harder, the hardness of Sachem Brook apparently being nearly as great as that of Hathaway Brook, one of your present sources of supply. The hardness of the water is due to limestone, of which there appears to be a large amount within the watersheds of Sachem and Hollow brooks. On the whole, the indications are that the waters of these brooks may be much harder than is desirable for domestic use.

With regard to the quantity of water that your sources of supply could be depended upon to yield in a dry year after development in the manner proposed, no definite prediction can be made with the information at present available to the Board. The information obtained from the report of your engineer as to the flow of the various brooks during a portion of last summer and fall indicates that in a very dry year the yield of your present sources, viz., Sackett, Ashley, Hathaway and Mill brooks and Ashley Lake, might be increased from fifty to sixty per cent. by the addition of Sachem, Hollow, May and Smith brooks, as proposed. As to the question of raising the dam at Ashley Lake two feet, the experience of the past seventeen years, in five of which the lake failed to fill in the spring, shows with sufficient conclusiveness that with present conditions but little benefit can be derived from raising the dam. If, however, the area of the watershed can be increased, it may be desirable to raise the dam.

Your present sources appear to be capable of supplying the city for the next two years, even if they are dry ones, if the consumption of water is kept within reasonable limits, unless Ashley Lake fails to fill in the coming

spring. In any case, should an emergency arise, a temporary additional supply, sufficient in quantity, is available by pumping water from Sackett Brook at your present temporary pumping station, though it is desirable to avoid the use of this water, if possible, on account of its excessive hardness. In view of all the circumstances, the Board would advise that you make surveys and investigations in the vicinity of Ashley Lake, to determine whether it is feasible to increase the area of its watershed and how large an additional area of watershed can be made tributary to the lake.

A few years ago the Board advised that West Pond in Washington was not a satisfactory source of water supply, on account of its color and organic matter. These are evidently derived from the vegetable matter of the swamp in and around the pond; and, in view of the fact that your present supply from Mill Brook can be readily supplemented by gravity from Roaring Brook below West Pond, and of the importance to your water-supply system of additional storage-reservoir capacity, it is worthy of examination to determine whether such reservoir capacity may not be obtained and a large drainage area made available by removing the vegetable matter in and around this pond.

It is also suggested that the question of the cost of taking water from Onota Lake by means of a pumping station at its southerly end be investigated.

In connection with these investigations, it is advisable to have the waters of the different available sources analyzed from time to time, so as to determine their general character at different seasons of the year.

With information as to the points mentioned, the Board can advise you more definitely as to the most appropriate source of additional supply for Pittsfield.

PLYMOUTH. The water commissioners of Plymouth applied to the Board, Dec. 10, 1895, for its advice relative to the best method of preventing the bad taste of their water supply, supposed to be due, as stated in the application, to the presence of *Uroglena* in the water of the source of supply (Little South Pond). The Board replied to this application as follows: —

BOSTON, May 7, 1896.

The State Board of Health has considered your application for advice as to whether there is any means of preventing the appearance in Little South Pond of the organism *Uroglena*, which imparts to the water a disagreeable taste and odor, and your request for advice in general as to the best method of improving the quality of the water supply of the town.

The organism *Uroglena* was first observed by the biologists of the Board

in the winter of 1891-92, when its presence was discovered in the water of Little South Pond and in two or three other sources at about the same time. Since then it has been observed in several other water supplies in the State, in some of which it has caused serious trouble, as at Plymouth.

The cause of the appearance of this organism in water is not known, and there is no known method of preventing its appearance or growth in the water of a pond or reservoir. In ponds in which its presence has been noted the experience has been that it occurs in the winter season, between October or November and March or April. In some ponds it has been present in nearly every year since it was first observed, though it appears to be present in less numbers and to affect the character of the water less seriously in some years than in others.

This has been the case in Little South Pond, where the organism has been present in greater or less numbers during nearly every year in the past five years, while previous to that time the water is said to have been excellent for many years. There is, however, a reference to complaint as to the quality of the water in the report of the Plymouth water board for 1877, but the exact cause of the trouble at that time does not appear to have been determined.

With reference to the best method of improving the quality of the water supply of the town, with the information at present available, the Board can advise you only in a general way.

The conditions in the vicinity of the ponds from which your present supply is drawn appear to be very favorable — judging from surface indications — to obtaining water from the ground with freedom, and this is true also of much of the territory about Plymouth. A good ground water, if delivered to consumers without exposure to light either at the source or in a distributing reservoir, is more satisfactory than a surface water, on account of its attractive appearance and freedom from taste and odor. If such a supply can be obtained in the vicinity of Little South Pond, in sufficient quantity to furnish all the water needed by the town at times when the quality of the present sources is unsatisfactory, the present conduit pipes might be used to convey the water by gravity to the pumping station and the town, as at present; and under the circumstances it would probably be more economical to take a supply from this vicinity rather than elsewhere.

If a ground-water supply is introduced, it will be necessary to make such changes in the distributing system as will make it possible to deliver water to consumers without exposure to light.

It might be possible to purify the water drawn from Little South Pond by filtration near the present pumping station, but such experiments upon the filtration of this water as have thus far been made have not been suffi-

cient to enable the Board to advise you as to the size of filter or the rate of filtration by which the purification of the water could be satisfactorily effected. If, as a result of experiments, it should be found that it is feasible to purify the water by filtration, it is not unlikely that the cost would, in the end, be greater than the cost of a ground-water supply, if a suitable source can be found near Little South Pond, as suggested. The trouble with the water has generally been most serious in cold weather, when much care might be necessary to secure satisfactory results by filtration; moreover, while the water supplied to the high-service system might be filtered and supplied to the pumps, as at present, by gravity, pumping might be necessary in order to supply the low-service system under satisfactory pressure, on account of the loss of head in the process of filtration.

Another method by which a water of satisfactory quality might be obtained would be to extend the present intake pipes around Little South Pond to connect with Great South Pond, making it possible to draw water from either source independently by closing the connection between the ponds. While it does not appear, from the limited number of examinations thus far made, that *Uroglena* has ever been present in the water of Great South Pond, it cannot be predicted that the organism may not appear in the future in this source as well as in Little South Pond, and at the same time. It is not certain, therefore, that a water of satisfactory quality would be obtained by this method at all times.

In view of all the circumstances, the Board would advise that you have an investigation made, to determine whether it is feasible to obtain a satisfactory ground-water supply from the vicinity of Little South Pond in connection with your present works, taking into consideration the necessity of keeping the water from exposure to light.

Before deciding to introduce a ground-water supply from the vicinity of Little South Pond, it is desirable that you determine whether the capacity of the present sources is sufficient for a considerable time in the future. If the capacity of present sources exceeds but little the present consumption of water by the town, it will probably be best to consider also the question of an additional supply, in connection with the question of obtaining a water of better quality.

The Board will, upon application, advise you further with reference to improving the quality of your water supply when you have additional information to present.

REVERE WATER COMPANY. The Revere Water Company applied to the Board, Nov. 9, 1895, for its advice relative to increasing their water supply by taking the water of a branch of Crystal Brook,

which flows from Castle Hill in Saugus, and also as to the quality of the brook which flows past the pumping station in Cliftondale.

A subsequent application was made, Feb. 20, 1896, for the advice of the Board relative to taking an additional supply from wells in the valley of the same brook, at its junction with Crystal Brook, near the corner of Main and Harvard streets in Saugus.

BOSTON, March 6, 1896.

On Nov. 9, 1895, the State Board of Health received from you an application with reference to the use of water for the supply of the towns of Revere and Winthrop from the tributary of Crystal Brook, flowing from the vicinity of Castle Hill in Saugus, and from the brook flowing past your present pumping station at Cliftondale. You propose to use the water during the winter season, and to allow the ground water of your present sources to accumulate for use in the summer season. Subsequently, a further request was received for advice as to procuring an additional supply from wells at a point in the town of Saugus near the corner of Main and Howard streets, which is in the valley of Crystal Brook, near the point where it is joined by the brook flowing from Castle Hill.

The towns of Revere and Winthrop are included in the metropolitan water-supply district, works for the supply of which are now being constructed, but it is not expected that these works will be in operation for two years.

The water of the wells at Revere has always been hard, but in the last three years, owing to an excessive drought, has been affected in an increasing degree by the infiltration of sea water, and it is desirable to avoid the use of this water entirely for the present. If pumping from these wells is avoided, the water will probably return to its former condition, but it is uncertain how long a time it will require. Under the circumstances, an additional temporary supply, capable of yielding about 500,000 gallons per day during the months from June to September, inclusive, and a less amount in other months, is needed.

The Board has caused an investigation of the proposed sources of supply to be made by its engineers, and samples of the water of the brooks mentioned in the application to be analyzed.

While the water of all of the brooks is colored to a greater or less degree by contact with vegetable matter in swamps, if the water were safe for drinking, it would undoubtedly be much more satisfactory for domestic use than the water of your wells at Revere, in its present condition.

The watersheds of both of the main tributaries of the brook flowing past the pumping station at Cliftondale contain a large population, and the danger of pollution entering the stream from this population makes the

water of these brooks, and consequently of the main brook, as a whole, unsafe for drinking. The watershed of the tributary of Crystal Brook, flowing from the vicinity of Castle Hill, contains a smaller population per square mile than the others, but the danger of the pollution of the water from this population is such that this brook also must be considered unsafe for drinking.

With regard to your second question, as to the advisability of procuring an additional supply of water from wells near the corner of Main and Howard streets, in the valley of Crystal Brook, in Saugus, no definite advice can be given, in the absence of any tests to indicate the probable quantity and quality of ground water to be obtained there. While Crystal Brook would not be a suitable source from which to take directly a supply of water for drinking, the use of water drawn from wells in the valley of the brook as a temporary source of supply would not necessarily be objectionable; and it may be said that the general conditions for obtaining an additional supply of water appear to be more favorable in the valley of this brook than elsewhere in the vicinity of your present works.

The Board would, therefore, advise that an investigation be made, with a view to determining the probable quantity and quality of water to be obtained from the ground in the valley of Crystal Brook in the vicinity of Howard and Main streets in Saugus.

The Board will, upon application, advise you further with reference to this source when you have additional information to present.

It has not been considered necessary, within the scope of this communication, to consider the provisions of chapter 400 of the Acts of 1893.

SHEFFIELD. The Sheffield Water Company applied to the Board, April 17, 1896, for its advice with reference to taking the water of the brook flowing from Three Mile Pond as a source of public water supply. The Board replied to this application as follows:—

BOSTON, June 5, 1896.

The State Board of Health has considered your application relative to a proposed water supply for Sheffield, to be taken from the brook, flowing from Three Mile Pond, known as Iron Work Brook, and has caused an examination of the proposed source to be made by one of its engineers, and samples of the water to be analyzed.

The chemical analyses show that the water is hard, and has a high color probably during most of the year; and, while it is probable that a sufficient supply for the town could be obtained from this source, the water cannot be regarded as of satisfactory quality for the purposes of a public water supply.

In reply to your application of last year, for advice with reference to the use of water from springs in the valley of Pool Brook, the Board stated that it regarded this source as an appropriate one from which to take a supply of water for the town. A second examination of the water of this source, by means of a chemical analysis in May of the present year, tends to confirm the opinion expressed last year, — that the water of the springs is soft, and of excellent quality for the purposes of a public water supply.

Judging from present information, it does not appear to the Board that there would be any material difference in the cost of works for taking water from either of the sources proposed; and, considering the excellent quality of the water of the springs in the vicinity of Pool Brook, the Board regards this source as the more appropriate one from which to take a supply of water for Sheffield.

SWAMPSCOTT. The Marblehead Water Company applied to the Board, Aug. 1, 1896, for its advice relative to an increase of their water supply by taking water from the ground in the neighborhood of Thompson's Meadow in the north part of Salem, near the boundary line between Salem and Swampscott. The Board replied to this application as follows: —

BOSTON, Sept. 3, 1896.

The State Board of Health has considered your application for advice with reference to an additional water supply for Swampscott and Nahant, to be taken from the ground in the vicinity of Thompson's Meadow, so called, situated in the southerly portion of Salem, very close to the boundary line between Salem and Swampscott, and has caused an examination of the proposed source of supply to be made, and samples of the water from test wells in the meadow to be analyzed. The analyses show that the water is somewhat hard, but is otherwise of excellent quality for the purposes of a public water supply. Whether it will remain so if water is pumped continuously from the ground here for a long time cannot be foretold with certainty from a single examination.

Information furnished by you as to the character of the soil found in driving the test wells indicates that a layer of gravel from 18 to 24 feet in thickness was found in all of the wells, at a considerable depth beneath the surface, from which water could be pumped with freedom by a hand pump. These conditions are favorable to obtaining water freely from the ground here by means of wells. On the other hand, the extent of the meadow is limited, and the land surrounding it contains a large amount of ledge. With these conditions, and in the absence of a suitable pumping test from

wells in the meadow, it is not practicable to advise you definitely with regard to the quantity of water to be obtained from this source.

In view of the poor quality of the water now drawn from the wells in the valley of Stacy's Brook, and the need of an additional water supply, the Board regards the proposed locality as a suitable place in which to seek an additional supply of water. The Board would advise, however, that, before building all of the works for taking a supply from this source, you put in the necessary wells and connect them to a temporary pump, and test them by pumping continuously for a period of at least two weeks, during dry weather, in order to obtain more definite information as to the probable yield of the wells than is possible at present. It would also be well to have samples of the water collected at various times during the test, to determine what change, if any, takes place in its quality.

The Board will assist you by making such further analyses of water as may be necessary, and will give you further advice with reference to this matter, if you desire, when you have additional information to present.

Another application was received from this company, Oct. 24, 1896, after trials had been made relative to the capacity of the proposed wells for supplying water. The Board replied to this application as follows: —

BOSTON, Nov. 5, 1896.

The State Board of Health received from you, on October 24, a second application with reference to a proposed water supply to be taken from the ground in Thompson's Meadow, in which you state that additional wells have been driven in this locality, and a pumping test made by pumping from the wells for a period of twelve days continuously, except for short intermissions, aggregating in all about one and a half hours, at a rate of nearly 200,000 gallons per day.

Samples of water collected and sent in by you during this test have been analyzed by the Board, with the result that the quality of the water shows no material change from the quality of samples taken from test wells in August, and in its present state is excellent for the purposes of a public water supply.

With regard to the quantity of water to be derived from wells in this locality, the tests thus far made are not conclusive; but, considering the character of the land about the meadow and of the meadow itself, it seems to be very doubtful whether this source can be depended upon to furnish enough water for the needs of Swampscott and Nahant at all times. Taking into account, however, the favorable results of the tests thus far made as to the quality of the water, the comparative economy of this source on

account of its nearness to the present distributing system, as compared with any other source from which it is at all probable that a satisfactory supply can be obtained, and the desirability of avoiding, so far as possible, the use of water from your present wells in the vicinity of Stacy's Brook, the Board is of the opinion that this source is a proper one from which to take water for Swampscott and Nahant, at the present time.

In locating works for collecting ground water, it is desirable that they be extended through the meadow sufficiently to secure as great a quantity of water as possible from the ground. If, upon actual trial, it shall be found that the yield of this source is likely to be too small for the towns of Swampscott and Nahant at all times, it is very desirable that you continue your investigations, with the object of securing a permanent supply of water of good quality and in sufficient quantity to make it possible to discontinue the use of water from your present wells, which are not satisfactory for a domestic water supply, being located in territory containing a large and rapidly growing population, and a portion of them being apparently affected to a considerable degree by the presence of sea water.

UXBRIDGE. The selectmen and board of health of Uxbridge, acting conjointly, applied to the State Board of Health, April 28, 1896, for its advice relative to the quality of the water of a well in that town, proposed as an auxiliary source of public water supply for the town. The Board replied to this application as follows: —

BOSTON, July 3, 1896.

The State Board of Health has carefully considered your application of April 28, 1896, for advice with reference to the quality of the water of a well in the Capron mill yard, which it is understood you propose to use as an auxiliary source of water supply for Uxbridge.

The Board has caused an analysis of a sample of water from this well to be made, recently, and, taking the results of this analysis in connection with the results of analyses made in previous years, it is found that the water varies greatly in character from time to time.

Under the most favorable conditions, when little or no water has been drawn from the well for a long time, the quality of the water is not objectionable for the purposes of a public water supply.

All the analyses show that the water had previously been polluted and subsequently purified in a large degree in its passage through the ground to the well, but some of the analyses show the presence of a very large amount of free ammonia in the water, indicating that at such times the water entering the well is not thoroughly purified.

There is reason to expect, therefore, that, if water is pumped from this

source in such quantity as would probably be necessary for the supply of the town, imperfectly purified water from the sewage-polluted sources in the vicinity may enter the wells, and under the circumstances the Board does not consider this well a safe source of domestic water supply.

WARE. The water commissioners of Ware applied to the Board, May 27, 1896, for its advice relative to the quality of the public water supply, in consequence of the appearance at times of a considerable amount of organic matter in the water. The Board replied to this application as follows: —

BOSTON, July 3, 1896.

The State Board of Health has considered your application for advice with reference to the quality of the water of your present water supply, and has caused an examination of your works to be made, and samples of the water to be analyzed.

The analyses show that the water as it comes from the ground is colorless and free from taste and odor, and contains only an insignificant amount of organic matter. The water of your distributing reservoir, on the other hand, contains at times a large amount of organic matter, and microscopical analyses show that it contains large numbers of organisms which impart to the water a disagreeable taste and odor. Complaints as to the character of the water supplied to consumers are doubtless due to the deterioration of the water stored in your distributing reservoir, and the annoyance caused by the presence of minute organisms in this water. The sample of material collected from a faucet and sent in by you was probably composed of some of the larger organisms which are developed in the distributing reservoir.

The remedy for the trouble with the water is to keep it from exposure to light from the time it is drawn from the ground until it is delivered to the consumers. To accomplish this, it will be necessary to cover the present distributing reservoir or build a new covered reservoir or tank.

There is no reason to think that, if the quality of the water of your present sources remains as good as at present, it will support any growth that will cause the water to deteriorate if kept entirely from exposure to light.

WELLESLEY. The water supply committee of Wellesley applied to the Board, May 15, 1896, for advice relative to certain plans proposed by the committee for increasing its water supply and protecting the present sources from pollution. The Board replied as follows: —

BOSTON, June 4, 1896.

The State Board of Health received from you on May 15 an application for advice with reference to increasing the water supply of the town and protecting the purity of the present supply. You request, in particular, advice with reference to the following matters: —

1. The curtailment of waste.
2. The construction of a number of low dams to hold back the water of Rosemary Brook, with the hope of increasing the yield of the present sources by filtration from the brook into the well and filter gallery.
3. The taking of water directly from Rosemary Brook as an additional supply.
4. The construction of a filter gallery or system of tubular wells in the valley of Rosemary Brook, west of Cedar Street and north of Worcester Street, above your present works.
5. The necessity of preventing the pollution of Rosemary Brook and its tributaries.
6. The removal of a small factory and buildings south of the driveway from Cedar Street to the pumping station.
7. The purchase of land south of the pumping station.

In connection with the question of constructing a filter gallery or system of tubular wells in the valley of Rosemary Brook, above your present works, you submit a plan showing the location of test wells, and samples of the soil from these wells collected in 1892.

With reference to the first question, — the curtailment of waste, — the Board is informed that, notwithstanding the fact that water is generally supplied through meters to consumers in the town, only about fifty per cent. of the water pumped is accounted for. The consumption of water per inhabitant in Wellesley in 1895 amounted to 42 gallons, which is not excessive, as compared with the consumption in other towns similarly situated. If, however, the consumption of water, as shown by your pumping records, could be reduced one-half, there would be a saving in the cost of pumping, and the necessity for an additional supply might not appear for a time. It is, therefore, desirable that an investigation be made, to determine whether a large quantity of water is lost by leakage or otherwise, and whether this loss can be prevented.

Judging from your experience last year, when dams were constructed upon Rosemary Brook, in the vicinity of your present sources, it appears that a considerable increase in the quantity of water entering the well and filter gallery was obtained by the construction of these dams. It is probable also that in previous years, before the construction of these dams, a

portion of the water entering your present sources was derived by filtration from the brook. Analyses of samples of the water of the well and filter gallery have been made from time to time by the State Board of Health, and its quality has apparently always been satisfactory. The well and filter gallery, however, are both situated close to the brook, and the chief danger from increasing the quantity filtering from the brook is that some of the water may pass too directly through the ground into the filter gallery or well, and not become satisfactorily purified in its passage. In some cases water taken from sources situated as yours are has continued to be satisfactory for many years, while in others, after a longer or shorter period of use, the quality of the water has deteriorated, owing to the imperfect filtration of the water from the stream or pond near by. Increasing the height of the water in Rosemary Brook by means of dams will tend to cause the water to filter more rapidly through the ground, thereby producing conditions more favorable to imperfect filtration.

With reference to the use of water taken directly from Rosemary Brook for the supply of the town, and the necessity of preventing the pollution of Rosemary Brook and its tributaries, the Board has caused an examination of this brook to be made by one of its engineers, and finds that it is exposed to direct sewage pollution from factories and dwelling-houses on its banks, and to pollution from farms and cultivated lands upon its watershed, and is, therefore, a dangerous source from which to take water directly for domestic purposes, and such water should not be distributed to your people. The watershed of the brook drains a part of the villages of Needham and Highlandville, and the population upon it is likely to increase rapidly in the future, so that it would not be possible, without excessive care, to prevent the pollution of the stream. Nevertheless, in view of the nearness of your present well and filter gallery to the brook, it is desirable that it be kept free from pollution, as far as is practicable.

An examination of the results obtained from test wells driven in the valley of Rosemary Brook, west of Cedar Street, and north of Worcester Street, in 1892, does not indicate that the conditions are favorable to obtaining a large amount of water from the ground there. South of Worcester Street the results of investigations were more favorable, judging from the samples of material submitted. The tests appear to have been confined to the vicinity of the north-westerly shore of Longfellow's Pond, and it is possible that better conditions could be found near the upper end of the pond and in the valley of the brook above, where the character of the surface indicates that the soil may be more porous.

The information available to the Board is not sufficient to enable it to advise you definitely at present with reference to the best method of increasing the water supply of Wellesley. The town is growing rapidly, and

in the selection of an additional water supply provision should be made for a large increase in the consumption of water in the future. The examinations thus far made in the valley of Rosemary Brook, above your present sources of supply, by means of test wells, have been unfavorable to obtaining a large increase in your present supply here; but, as already stated, the conditions appear, from surface indications, to be somewhat more favorable farther up the valley, and it is possible that a large addition to your present supply can be obtained in this region.

It is to be considered, however, that the population in the valley of Rosemary Brook is already large, and may increase rapidly in the future, owing to its nearness to the metropolitan district; and, before deciding upon a plan for increasing the water supply of Wellesley by the construction of further works in this valley, the question of the feasibility of obtaining a supply of water for domestic purposes here that can be maintained in a satisfactory condition for a reasonable time in the future, without excessive cost, should be carefully considered. It is also very important, before deciding definitely as to a source of additional water supply, that you determine the feasibility and probable cost of obtaining a supply from, or in connection with, the metropolitan district.

The presence of a small factory and other buildings between Cedar Street and the wells south of the driveway from Cedar Street to the pumping station does not appear to be, under present conditions, a serious menace to the quality of your water; and the removal of these buildings is not essential, if means are taken to prevent sewage from polluting the stream or from getting into the ground, and so passing to the filter gallery or well.

With reference to the advisability of purchasing any of the land lying east of Cedar Street, south of the pumping station, it may be said that, if water from this territory finds its way into your present sources of supply, it is desirable that the land be owned and controlled by the town. It is not feasible to determine how much of this land it is desirable for the town to control, except by experiment.

In conclusion, the Board would advise that you have the whole subject of your present and future water supply thoroughly examined by a competent engineer, to determine what measures are necessary to protect the purity of your present sources of supply, and the most appropriate source from which to take an additional supply.

The Board will, upon application, advise you further in this matter when you have the results of further investigations to present.

WILLIAMSBURG. The selectmen of Williamsburg applied to the Board, Feb. 11, 1896, for its advice relative to a water supply for

the town to be taken from the East Branch of Mill River. The Board replied to this application as follows: —

BOSTON, Oct. 1, 1896.

The State Board of Health has carefully considered your application with reference to a proposed water supply for Williamsburg, to be taken from the East Branch of the Mill River, upon which it is proposed to construct a small reservoir above the village, and has caused an examination of the proposed source to be made by one of its engineers, and samples of the water to be analyzed.

About three-fourths of a mile up stream from the place where it is proposed to locate the reservoir the East Branch is joined by Bradford Brook, and at the point of junction the two streams have nearly equal watersheds. These streams will furnish by far the greater portion of the water which will enter the proposed reservoir, and samples from each of them, collected at different seasons of the year, have been analyzed with a view to comparing the quality of the water.

The water of the East Branch above the Bradford Brook is soft, has very little color, and contains a small amount of organic matter for a surface water. The water of Bradford Brook, on the other hand, is harder, and has at times considerable color, and contains a greater amount of organic matter. The quality of the water of the proposed reservoir would be somewhat better than the Bradford Brook water, but not so good as the water of the East Branch, above Bradford Brook.

The watershed above the proposed reservoir contains a considerable number of farmhouses, though the population per square mile is small. Several of the buildings are located near the streams, particularly in the Bradford Brook watershed, and provision will have to be made to prevent sewage from these houses entering the streams and polluting the water supplied to the town. In the watershed of the East Branch, above Bradford Brook, the houses are more remote from the stream than in the Bradford Brook watershed, and the population per square mile is considerably smaller.

Considering all the circumstances, therefore, a more satisfactory supply for the town could be obtained by taking water from the East Branch, above the Bradford Brook, than at the point proposed.

With regard to the quantity of water that would be furnished by the East Branch, below Bradford Brook, it may be said that the indications are that the quantity would be ample at all times for the supply of Williamsburg. It is also probable that an ample supply would be obtained by taking water from the East Branch, above the Bradford Brook; and, in case an additional supply should be needed at any time, provision might be

made for drawing water from Bradford Brook in emergencies. The cost of taking a supply from the East Branch, above the junction of Bradford Brook, would probably be somewhat greater than at the place proposed in the application; but, in view of the better quality of the water, and the less number of dwellings and their distance from the stream, the Board would advise the town to take its supply from the East Branch, above Bradford Brook, rather than at the point proposed.

WOBURN. The water commissioners of Woburn applied to the Board, April 30, 1896, for its advice in regard to the existence of a disagreeable taste and odor in the public water supply. The Board replied to the application as follows:—

BOSTON, June 6, 1896.

The State Board of Health has considered your application for advice with reference to a disagreeable taste and odor in the water supply of the city, and has caused an examination of your distributing reservoir to be made, both when the reservoir was full and after the water had been completely drawn off.

Frequent chemical analyses of the water of your filter gallery for several years have shown that the water is colorless and free from taste and odor, and contains very little organic matter, while microscopical examinations show that the water is practically free from vegetable or animal organisms. Examinations of the water of the distributing reservoir, on the other hand, have shown that the water contains at times a large amount of organic matter, and often large numbers of vegetable organisms which impart to the water a disagreeable taste and odor.

These organisms may grow as abundantly and affect the quality of the water as seriously in the colder months of the year as in the warmer months. There is no doubt that the disagreeable taste and odor complained of in the water supply of the city of Woburn is due to the presence of these organisms in the distributing reservoir.

It has been well known for many years that a ground water deteriorates on exposure to light in an open reservoir, such as that in use at Woburn, and experience has clearly shown that the remedy for this trouble is to keep the water from exposure to light from the time it comes from the ground until it reaches the consumer. To accomplish this in the case of the Woburn water works, it will be necessary either to cover the present distributing reservoir or to build a new covered reservoir or tank, which may be of comparatively small capacity and sufficient only for ordinary purposes, if the present reservoir is kept for use in emergencies.

There is no reason to think that, if the quality of the water of your

present filter gallery remains as good as at present, it will support any growth that will cause it to deteriorate, if kept entirely from exposure to light.

SEWERAGE AND SEWAGE DISPOSAL.

The following is the substance of the action of the Board during 1896, in reply to applications for advice relative to sewerage and sewage disposal: —

AGAWAM. The selectmen of Agawam applied to the Board, June 10, 1896, for its advice relative to the disposal of sewage from a proposed sewer for the village of Mittineague, into the Westfield River. The Board replied to this application as follows: —

BOSTON, July 3, 1896.

The State Board of Health received from you, on June 8, an application for advice with reference to the disposal of the sewage of a portion of the village of Mittineague, situated in the northerly part of Agawam, by discharging it without treatment into the Westfield River. The application was accompanied by a plan showing three possible outlets of the proposed sewer, two of which are into the tail-race leading from the Worthy Paper Company, and a third into the Westfield River, about 100 feet below the outlet of the tail-race.

The Board has carefully considered your application, and has caused an examination of the locality to be made by one of its engineers, and concludes that the disposal of the sewage of this village by discharging it untreated into the Westfield River is permissible for the present.

The sewage should not be discharged into the tail-race, because at times when the mill is not running there is no flow of water in the tail-race, and the discharge of sewage into it would, under these conditions, cause a nuisance.

In discharging the sewage into the river, the Board advises that the outlet of the sewer be carried well out into the stream, so that floating matters from the sewage may not lodge on the shore in the vicinity of the outlet.

ATTLEBOROUGH. A communication was received from the Board of Health of Attleborough, Aug. 29, 1896, stating that they had received a petition from citizens of Attleborough, remonstrating against the discharge of sewage from that town into Ten Mile River, at the same time requesting the Board "to examine the

locality, and offer suggestions as to a remedy." The Board replied to this letter as follows: —

BOSTON, Oct. 1, 1896.

The Board has caused an examination of the locality to be made by one of its engineers, and finds that the sewer in question discharges into the river just below the bridge at County Street, and that there is another sewer from Attleborough, discharging into the river about 4,000 feet further down stream. The lower sewer outlet is located just above the Dodgeville mill pond, which is said to give off very offensive odors at times. There are several other mill ponds upon the stream below.

From information furnished by you, it is learned that these sewers were originally constructed for surface drainage only, and you estimate that the sewage from about 3,500 people is now disposed of by discharging it directly into the river through these sewers. The Board is also informed that large quantities of ice are harvested from the mill pond below the sewer outlets, and that the river is used as a direct source of water supply by the town of East Providence, in Rhode Island, situated a little less than ten miles below Attleborough.

The discharge of sewage from 3,500 people into a stream of the size of the Ten Mile River would inevitably produce a nuisance, and the condition of the mill pond below the sewer outlets will grow rapidly worse, owing to the decomposition of organic matter deposited from the sewage upon the bottom and sides of the pond. Extending the sewers to a point of discharge further down the stream would simply transfer the nuisance to another locality. The only way by which the nuisance can be avoided is by discontinuing the discharge of unpurified sewage into the river. The disposal of sewage by the present method is not only a nuisance to the inhabitants of Attleborough, but is contrary to existing laws, and is a source of great danger to those using ice and water from the river below Attleborough.

Under the circumstances, the Board considers it very important that a proper method of sewage disposal be adopted, and put in practice without delay. The Board is prepared to assist you in this matter, if you desire, by advising you with reference to any plans that you may wish to submit to it providing for the disposal of the sewage of Attleborough.

BROCKTON. The mayor of Brockton applied to the Board, Sept. 22, 1896, for its advice relative to plans for the drainage of two small districts in Brockton. The Board replied to this application as follows: —

BOSTON, Sept. 24, 1896.

The State Board of Health has carefully considered the plans presented by you for the approval of this Board, under the provisions of chapter 309 of the Acts of 1889, providing for the drainage of two small districts in the city of Brockton, — one known as the Weston Street district and the other as the Battles Street district, — and hereby approves the plans for the said drainage systems.

BROCKTON. The city engineer of Brockton applied to the Board, Sept. 14, 1896, requesting the opinion of the Board relative to the propriety of fertilizing the growing crops upon its sewage disposal areas "with frequent doses of sewage." To this application the Board replied as follows: —

BOSTON, Oct. 2, 1896.

In reply to your letter of September 14, asking the opinion of this Board as to the propriety of using the growing crops on your sewage fields as food for human beings, the Board instructs me to say that in its opinion no harm can arise from the use of such vegetables as are cooked before being used, and such grain and other products used for food which cannot come in actual contact with sewage.

DANVERS. The board of health of Danvers applied to the State Board, Feb. 7, 1896, for its advice relative to the disposal of the sewage of certain morocco shops in that town. The Board replied to this application as follows: —

BOSTON, July 22, 1896.

The State Board of Health received from you on Feb. 7, 1896, an application for advice with reference to the disposal of the manufacturing sewage from the morocco shops or tanneries in Danvers which is now discharged into Crane's River, in which you state that you have under consideration a plan providing for the discharge of the sewage into two large settling tanks, through which you propose to cause the sewage to flow slowly, thereby allowing the heavier matters to settle, and to discharge the effluent into the stream; and you request advice as to whether, by this method, if the tanks are frequently cleaned out, the difficulty of the present system of disposal would not be largely overcome.

Since the application was received the Board has been investigating the character of this sewage, and conducting experiments with a view to suggesting a practicable method of disposing of it in such a manner as to prevent further objectionable pollution of the stream and mill pond. While these investigations have not yet been carried far enough to enable the Board to advise you definitely as to a method of finally disposing of sewage

of this character, the results thus far obtained indicate that it will probably be feasible to dispose of it by some method of filtration after the greater portion of the suspended matter has been removed. It has been found, in the course of the investigations, that much of the suspended matter in the sewage settles out readily upon allowing it to remain practically undisturbed, and experiments at the factory indicate that somewhat more than half of the putrescible organic matter can be removed from the sewage by allowing it to stand for a period of about two hours.

In view of the desirability of keeping as much organic matter as possible out of the stream, and of the probable necessity for the use of settling tanks in connection with any method of disposal that is likely to be adopted, the Board advises, as the first step in overcoming the objectionable condition, that you construct settling tanks of sufficient capacity to allow the sewage to settle for a period of two hours, if it shall be found upon examination that the tanks can be operated satisfactorily by gravity.

Investigations as to the quantity of sewage discharged from the tanneries and the rate of flow indicate that the rate is quite regular, and that the quantity averages about 20,000 gallons per hour during working hours. In order to allow this quantity of sewage to settle for a period of approximately two hours, settling tanks having a larger capacity than those proposed by you will be necessary.

In order to obtain the full benefit that may be derived from the use of settling tanks, it is essential that all of the sewage now discharged into the brook be collected and conveyed to the tanks, and that the tanks be cleaned out frequently. Once in two days may be often enough, though it may become necessary to clean them out daily, so that their capacity may not be greatly reduced, and the length of time allowed for sedimentation materially shortened by allowing the sediment to accumulate to a considerable depth in their bottoms. The tanks, therefore, should be so located and arranged that the supernatant liquid may be drawn off when necessary, and the sludge readily removed at frequent intervals. The tanks should also be designed with a view to the possible necessity of pumping the supernatant liquid to a place of disposal, if this should subsequently be found necessary.

With properly designed tanks, operated with care, a very large portion of the suspended matters which constitute much of the total putrescible organic matters in the sewage can be prevented from entering the pond.

The quantity of sludge to be removed will be large, but not so great that it cannot be removed in carts without special difficulty. The so-called odorless carts may be best adapted to the purpose. The sludge can be disposed of upon filter beds not far from the factory, where areas well suited to the purpose can be found.

The Board would advise that the work of designing the tanks and of preparing the areas for the disposal of the sludge be committed to an engineer of experience in matters relating to sewage disposal.

An examination of the condition of the mill pond and the character of the nuisance caused by it shows that the bottom and sides of the pond, especially near its upper end, are covered with organic matter from the sewage, and at times when these areas are uncovered the odor from them is very offensive. When the pond is full and these areas are covered with water, it appears that the nuisance is much less serious.

In view of this condition, and of the probability that, even if the discharge of sewage into the pond should be wholly prevented at once, there would still, for a considerable time, be a serious odor from these areas when exposed, the Board would suggest that you consider the feasibility of obtaining control of the mill privilege at the outlet of the pond, and of keeping the pond full at all times.

The Board will again communicate with you with regard to this matter when the results of further investigations now being made are available.

DANVERS LUNATIC HOSPITAL. The trustees of the Danvers Lunatic Hospital applied to the Board for its advice, Sept. 27, 1895, relative to a plan for disposing of the sewage of the hospital by precipitation with chemicals, followed by filtration through a small area of coke. This application was withdrawn, Oct. 28, 1895, and afterward resubmitted, with modified plans. The Board replied to this application as follows: —

BOSTON, May 7, 1896.

The State Board of Health has considered your application with reference to a proposed system of purification for the sewage of the Danvers Lunatic Hospital, the essential features of which are a precipitating tank, in which it is proposed to precipitate the solid matters of the sewage by the application of chemicals, and a filter bed composed of coke, having an area of about a quarter of an acre and a depth of three feet, through which it is proposed to filter the sewage after it passes through the precipitating tanks.

The quantity of water used for the supply of the hospital is from 100,000 to 125,000 gallons per day, and, assuming that this represents approximately the amount of sewage to be disposed of, the rate of filtration through the coke filter would be about 500,000 gallons per acre per day. The sewage from the hospital appears to be quite dilute, judging from the results of an analysis made by the Board, and if the usual percentage of organic matter should be removed by chemical precipitation, it is possible that for a time, with great care in the management of the filter,

a large percentage of the remaining organic matter would be removed from the sewage by the proposed filter; but it is probable that, in order to purify the sewage satisfactorily, the size of the filter would have to be considerably enlarged.

The disposal of the sewage of the hospital by this plan would involve a very great expense both for construction and maintenance, as compared with the disposal of the sewage on land if an area suitable for the purpose can be found within a reasonable distance of the hospital.

With a view to learning whether there is any such land in the vicinity of the hospital, the Board has caused a general examination of this territory to be made by one of its engineers, and finds that there is a considerable area of sandy land, situated on the south-westerly side of West Street, between the street and the Ipswich River, a little over half a mile from the hospital buildings, portions of which appear to be well adapted for the purification of sewage by intermittent filtration; moreover, the situation of this area is such that sewage can probably be conveyed to it by gravity at a small expense from your present sewage carriers, which are at present laid to within about 1,000 feet of this area.

In view of all the circumstances, the Board would advise that you have an investigation made, to determine the feasibility of disposing of the sewage of the institution upon this area by intermittent filtration; and the Board will, upon application, advise you further with regard to this matter when you have the results of further investigations to present.

METROPOLITAN SEWERAGE COMMISSION. An application was received from the Metropolitan Sewerage Commission, Oct. 9, 1895, under the provisions of chapter 406 of the Acts of 1895, for the approval of the Board of a system of sewage disposal for a district lying partly in the city of Boston and the towns of Milton, Hyde Park and Dedham, in the valley of the Neponset River, and for a portion of Newton and the town of Brookline lying in the valley of the Charles River. The Board replied to this application as follows:—

BOSTON, Feb. 18, 1896.

The State Board of Health has considered your application with reference to a proposed system of sewage disposal for that portion of the city of Boston and the towns of Milton, Hyde Park and Dedham lying within the valley of the Neponset River, and portions of the city of Newton and the town of Brookline lying within the valley of the Charles River. The application is accompanied by a plan and profiles and a report of your engineer, giving details of the proposed scheme approved and adopted by

your Board, in accordance with a provision of chapter 406 of the Acts of 1895.

The plan provides for a main sewer from a point on Worley Street, near Weld Street, in the West Roxbury district of the city of Boston, through various streets and private lands to the bank of the Charles River, a short distance above the Brookline water works pumping station; thence in the vicinity of the right bank of the Charles River and along the left bank of Mother Brook and the Neponset River to the Dorchester intercepting sewer of the city of Boston at Central Avenue in Dorchester. The capacity of the latter sewer is limited by a section below Baker's Court in Dorchester, which has a capacity of only about 20 cubic feet per second; and it is estimated that the capacity of this sewer, if the sewage of the Neponset valley is discharged into it, will be attained about the year 1905. To provide for the disposal of the sewage after this date two methods are suggested, by either of which the sewage in the Neponset intercepting sewer would be diverted at a point on River Street, Hyde Park, about 500 feet below the Mattapan paper mill, and conveyed by gravity either to the Boston main drainage sewer at Squantum or an independent outlet at Nut Island in Quincy. With this end in view, the Neponset intercepting sewer has been designed with a capacity above the point of diversion estimated to be sufficient for the probable needs of the valley until 1930, while below this point the capacity is proportioned to that of the limiting section of the Dorchester intercepting sewer, estimated to be sufficient until 1905.

In designing the Boston main drainage system it was anticipated that the sewage from the higher portions of the district bounded by the Charles River, Mother Brook and the Neponset River could be at some future time intercepted by a "high-level" sewer and conveyed to Squantum by gravity, thus affording relief to the pumping station and tunnel when the flow of sewage shall tax their capacity; and provision was made, in the construction of the works, for the connection of such a sewer with the outfall works at Squantum and Moon Island. Your investigations indicate that a feasible route for this sewer can be found, which would intercept the proposed Neponset valley sewer at the point where its size is reduced, on River Street in Hyde Park. Your investigations also indicate that a feasible route for an intercepting sewer from this point to Nut Island may also be found. With regard to disposing of the sewage in the future by either of these methods the Board can express no opinion, with the information available at the present time, and you have verbally requested that the consideration of these matters be omitted. The Board has accordingly considered only that portion of your application which refers to the disposal of the sewage of the Neponset valley by means of the proposed sewer shown on the plan contained in the seventh annual report of your

Board, opposite page 38, which provides for the discharge of the sewage into the Dorchester intercepting sewer at Central Avenue in Dorchester.

With regard to this portion of the scheme, the Board finds that the proposed sewer will provide a satisfactory means of disposal for the sewage of the territory in the Charles and Neponset valleys which it is estimated to serve, probably until about the year 1905, if care is taken in the construction of the main sewer and tributary systems to exclude surface and ground water from the sewers so far as possible, and if the amount of manufacturing sewage is restricted by preventing the discharge into the sewer of water from manufacturing establishments that can be properly discharged into natural water courses.

The size of the proposed sewer above the point where it is expected that the sewage will be diverted at some future time appears to be sufficient to make a reasonable provision for a population as great as may be expected to be connected with this portion of the system in 1930, so far as can be judged by present indications. The size of the sewer below the point where it is expected that the sewage of the Neponset intercepter may be diverted is such as to serve the low districts in Dorchester and Milton for many years after the sewage of the upper portion of the system is diverted.

The Board approves the plan of disposing of the sewage of the Neponset valley by discharging it into the Dorchester intercepting sewer of the city of Boston, but expresses no opinion as to the most appropriate method of disposal to adopt after the capacity of this sewer is reached. The increase in the amount of sewage to be disposed of by the Boston main drainage system will necessitate before long the enlargement of the reservoir capacity at Moon Island, and the necessity for enlargement will be hastened by the addition of the Neponset valley sewage.

It is understood that the sewerage systems to be connected with the Neponset valley sewer shall be constructed upon the so-called "separate" plan, and that no sewage overflows will be used in connection with the main sewer or tributary systems.

On March 18, 1896, the Metropolitan Sewerage Commission again wrote to the Board, as follows: —

110 Boylston Street, Boston, March 18, 1896.

Gentlemen: — In your reply of Feb. 18, 1896, to our application for approval of plans for sewage disposal for Neponset River valley, at the close you say: "It is understood that the sewerage system to be connected with the Neponset valley sewer shall be constructed upon the so-called 'separate' plan, and that no sewage overflows will be used in connection with the main sewer or tributary systems." As we are

informed and understand, you do not, by the use of the words "no sewage overflows will be used," etc., intend to prohibit or prevent the construction of such provision for temporary overflows as it would seem necessary should be provided for use in case of accident or necessity of repair of trunk sewer. Unless we hear from you to the contrary, we shall proceed to construct the main trunk sewer and approve local connections therewith, making and requiring such provision for such overflows similar to those provided and required in the Charles River and north metropolitan systems, to be used only in case of emergency.

Very respectfully yours,
For the Board,
(Signed) EDWARD P. FISK, Clerk.

The Board of Health replied to this letter as follows: —

BOSTON, March 26, 1896.

The State Board of Health received from you, on March 18, a communication with reference to the use of sewage overflows in connection with the proposed Neponset valley sewerage system, in which you state that unless you hear from the Board to the contrary you shall proceed to construct the main trunk sewer and approve local connections therewith, making and requiring such provisions for such overflows similar to those provided and required in the Charles River valley and north metropolitan systems, to be used only in case of emergency.

The plan presented by you for an intercepting sewer for Neponset River and Mother Brook basins, including a portion of the Charles River basin, which this Board approved in its communication dated Feb. 18, 1896, did not contain any provision for sewage overflows, and no mention of sewage overflows was made in the report of your engineer submitted with the application.

Before the Board can approve a plan providing for sewage overflows, it will be necessary that you submit a plan showing the location of the proposed overflows, with a description of the proposed method of constructing and operating them.

The Sewerage Commission again wrote to the Board, April 18, 1896, as follows: —

110 BOYLSTON STREET, BOSTON, April 18, 1896.

GENTLEMEN: — In response to your communication of March 26, 1896, stating that a plan will be required showing the proposed overflows from the Neponset valley intercepting sewer, with a description of method of

construction and operation, the Board desires to state as follows: The Charles River system has been operated since 1892 as a branch of the Boston main drainage. During the rainy weather, and when the pumps are not in operation, the trunk sewer of the Boston system has been surcharged, flooding the Charles River branch, and requiring the construction and maintenance of automatic overflows for the efficient and safe operation of the system. The Board has deemed it expedient to require, for safety and convenience in maintaining and repairing the sewer, and as a further safeguard against flooding from Boston's system that cities and towns tributary to the Charles River system should also construct and maintain automatic overflows at all their connections from areas of considerable size.

The Neponset valley intercepter, like the Charles River main, will, when completed, be operated as a branch of the Boston system; and it is anticipated that it also will be subject, at its lower end, to flooding during the surcharged condition of the Boston trunk sewer. The Board is of the opinion that the safe operation of the Neponset branch will require the following overflows from the main sewer: —

First. — At Granite bridge, Dorchester, an automatic overflow into the tidal currents of Neponset River, having a carrying capacity equal to the main sewer at that point.

Second. — Near Mill Lane, Dedham, an overflow into Mother Brook, having a carrying capacity equal to the main sewer at that point, controlled by a Penstock valve, to be operated by hand, and only when the main sewer is surcharged at that point.

Plans of the proposed overflows are submitted, as requested.

For convenience and safety in maintenance, to provide against possible accident or injury to the main sewer or flooding at low levels from Boston main sewer, the Board is of the opinion that, as in the Charles River branch, automatic safety overflows should be provided from all local connections receiving drainage from ten acres or more; such overflows, above East Street, Dedham, to be permanently sealed off, and never used so long as the Charles River and its shores are used as a source of domestic water supply.

At the date of the engineer's preliminary report on the Neponset valley sewer the Board had not decided to acquire the Dorchester intercepter from Central Avenue to Granite bridge, and were not prepared and did not at that date ask advice in the matter of overflows from the main sewer. With the exception of Milton, no city or town of the valley above Central Avenue had then prepared any studied scheme for its local connections, and the Board were equally unprepared to ask advice at that date in the

matter of overflows from local connections. The engineer to the Board, after conference with the engineers for the tributary cities and towns, has prepared a study for a system of branches for local connections, which are shown on the accompanying map, subject to such minor modifications of size, location, etc., as may necessarily be developed during the more detailed surveys for the construction of local sewers. The Board desire to approve and adopt automatic relief overflows at all the connections shown, with the understanding that such as are above East Street, Dedham, shall not be opened for use so long as the Charles River is used as a source of water supply for Brookline, Newton and other cities. A characteristic study for one of these connections is submitted, and your advice and approval is asked in the matter of overflows from the main sewer and from local connections as outlined above.

Respectfully submitted,
For the Board,
(Signed) EDWARD P. FISK, *Clerk.*

The Board of Health replied to this application as follows: —

BOSTON, May 7, 1896.

The State Board of Health received from you, on April 18, an application for approval of proposed sewage overflows in connection with the proposed Neponset valley intercepting sewer, accompanied by plans showing the location of proposed overflows from the main sewer and tributary systems and designs for these overflows. Two of these overflows are proposed for the discharge of sewage from the main intercepting sewer, and it is understood that the others are automatic overflows, to be connected with the tributary systems near their junction with the main sewer, by which sewage from the tributary sewers may be discharged into local water courses when the sewage in the intercepting sewer rises to a certain height. One of the proposed overflows presented by you is located upon the main sewer at Granite bridge, but, since this is below the portion of the sewer to which the reply of the Board dated February 18 was limited, at your request, the Board has omitted the consideration of this overflow.

It is stated in the application that your Board "desire to approve and adopt automatic relief overflows at all connections shown, with the understanding that such as are above East Street, Dedham, shall not be opened for use so long as the Charles River is used as a source of water supply for Brookline, Newton and other cities." As the discharge of sewage into the Charles River in this vicinity is, under present conditions, prohibited by law, this Board cannot approve any overflows upon this portion of the sewer at the present time. The overflows under consideration, therefore,

are those included on the main sewer and tributary systems, between the point where the sewer crosses East Street in Dedham and its junction with the Dorchester intercepting sewer at Central Avenue, Dorchester.

By the existing conditions, sewage from all overflows in this district would naturally be discharged either into Mother Brook or the Neponset River, or tributaries of these streams. There are several dams along Mother Brook and the Neponset River, forming mill ponds in some cases of considerable size, and all of the proposed overflows would be above one or more of these dams. There is a large and rapidly growing population in the vicinity of these streams and their tributaries, and, in the opinion of the Board, it is desirable that these streams be kept free from pollution, and that the discharge of sewage into them be prevented, if possible.

Regarding the danger of the proposed main sewer and tributary systems becoming surcharged by sewage backing up from the Boston system, the Board is informed that by existing provisions the Dorchester intercepting sewer is automatically disconnected from the Boston main drainage sewer at times when the latter is surcharged, and provision is made whereby the Dorchester intercepting sewer may at such times discharge into tide water; moreover, according to the plan approved by this Board in a communication to your Board, dated Feb. 18, 1896, the bottom of the Neponset valley sewer at its lower end in Central Avenue, Dorchester, is at about grade 20, or several feet above high water. It does not seem to this Board that there is danger that the Neponset valley sewer may be surcharged from this cause.

Regarding the necessity of automatic overflows for safety and convenience in maintaining and operating a separate system of sewers, much information is furnished by experience in the operation of such systems already in use in this State. A number of such systems have been in successful operation in some cases for several years without automatic overflows, and information regarding these systems indicates that the necessity for such overflows has not arisen.

In view of all the circumstances, the Board declines to modify its approval, under date of Feb. 18, 1896, of a system of sewage disposal for Neponset River valley which had been submitted by you, by adopting, as a part of that plan, the plan of automatic relief overflows proposed in your communication of April 18, 1896.

It is possible that there are points in the system not known to this Board where unusual emergencies may occur, and where safety would require an outlet gate which can be opened temporarily; if such points are found to exist, this Board will consider plans you may present in regard to them; but this Board is desirous to avoid discharging sewage above any of the mill dams on Neponset River, when not absolutely necessary.

METROPOLITAN SEWERAGE COMMISSION (Dorchester intercepting sewer). The sewer commissioners applied to the State Board of Health, May 2, 1896, for the approval of the Board of the taking of a part of the Dorchester intercepting sewer to constitute a part of the sewerage system for a part of the city of Boston and for the towns of Dedham, Hyde Park and Milton. The Board replied to this application as follows: —

BOSTON, June 6, 1896.

The State Board of Health has considered the application submitted by you on May 4, 1896, in which you request the approval by this Board of the taking by the Metropolitan Sewerage Commissioners of the portion of the Dorchester intercepting sewer between Central Avenue and Granite Avenue, in Dorchester, as a portion of the proposed Neponset valley sewerage system, provided for by chapter 406 of the Acts of the year 1895, and, having carefully considered the plans, hereby approves them as a part of the system of sewage disposal for the Neponset valley, supplementary to the plans already approved by this Board.

NATICK. The sewerage committee of Natick applied to the State Board of Health, July 1, 1896, for its approval of a system of sewerage and sewage disposal being constructed for the town, under the provisions of chapter 459 of the Acts of 1894. The Board replied to this application as follows: —

BOSTON, Sept. 3, 1896.

The application was accompanied by plans showing a general system of sewerage for the thickly settled portion of the town, and a main sewer leading from the town through West Central Street to a pumping station located on the northerly side of the street, and between it and the Boston & Albany Railroad and close to the southerly end of Lake Cochituate. From the pumping station a force main extends across the railroad and private land to Speen Street, through this street to the Worcester turnpike, and westerly, along the turnpike, to a place of disposal upon land upon the opposite side of the street from land now used for a similar purpose by the town of Framingham.

The proposed filtration area indicated upon the plans contains an area of 97½ acres of land, of which it appears that 74 acres can be utilized for sewage-disposal purposes. At the time the application was made the construction of the system had nearly been completed.

The Board, having carefully examined and considered the plans submitted, hereby approves the system of sewerage and sewage disposal, as indicated by these plans.

It will be unnecessary to prepare all of the filter beds indicated upon the plan at the present time, but at least eight of these beds should be completed early in 1897, to provide for the disposal of sewage that may be expected to reach the beds as soon as the sewers now constructed shall have come into general use, and additional beds may then be prepared from time to time as they are needed.

SPRINGFIELD. The mayor of Springfield applied to the Board, April 21, 1896, for its advice relative to the construction of a sewer for a certain portion of the city, having its outlet into the Connecticut River at the foot of Elm Street. The Board replied to this application as follows: —

BOSTON, May 7, 1896.

The State Board of Health received from you, on April 21, 1896, an application with reference to the proposed extension of the Elm Street sewer to the bank of the Connecticut River, and the construction of a pipe to discharge the dry-weather flow of the sewage at a distance from the shore of the river. The Board finds that the proposed extension appears to be adapted to disposing of the dry-weather flow of sewage at such a distance from the shore that it is not likely to return until it becomes well diluted, and approves the disposal of the sewage from this sewer by the method proposed. As in the case of the plans submitted last year, the Board advises that it would be well to avoid the upturning of the discharge pipe at the end, and to provide a free outlet, with no depressed portion of the pipe in which solids from the sewage may be deposited.

STOCKBRIDGE. An application was received from the sewerage committee of Stockbridge, Nov. 27, 1896, for advice relative to a proposed system of sewerage and sewage disposal in that town. The Board replied to this application as follows: —

BOSTON, Jan. 8, 1897.

The State Board of Health received from you, on Nov. 27, 1896, an application for advice with reference to a proposed system of sewerage and sewage disposal for the village of Stockbridge, accompanied by a plan showing the territory which it is intended to include in the system at the present time, and a plan of a proposed filtration area near the Housatonic River, north-west of the village. Subsequently, plans were received showing the locations of the proposed sewers and the proposed method of preparing the filtration area.

The Board has examined the plans submitted and has caused an examination of the locality to be made by its engineer, and samples of the

soil, collected from test pits on the proposed filtration area, to be analyzed.

The plans show that it is feasible to collect the sewage from practically all of the village, and deliver it by gravity upon the filtration area. The exclusion of storm water from the sewers, as proposed, is very desirable, since smaller sewers will be required, and the quantity of sewage to be purified will be much less than if storm water should be admitted. The proposition to place underdrains beneath the sewers should also be carried out, for the same reason.

The area proposed for the disposal of the sewage appears to be the most suitable one which it is practicable to use for the purpose without pumping, and its location is satisfactory from a sanitary point of view. Examinations of the ground where the filter beds are to be located, by means of test pits, have shown that beneath a layer of loam and soil at the surface there is a layer of sand from 2 to 3 feet in thickness, which, if properly underdrained, is suitable for the purification of sewage by filtration. The depth of the material is less than is necessary for the proper filtration of the sewage, but it is feasible to increase the depth, as proposed in the plans submitted, to about four feet, by removing the soil from the present surface and replacing it with good filtering material from higher land in the vicinity, where suitable material is found. The depth of the filters will be somewhat less than is desirable, but the quality of the filtering material is such that a well-purified effluent can be obtained from the proposed beds with reasonable care in their management.

According to the plan, about 2.2 acres of filter beds can be prepared here, and a further area of a little over an acre situated near the river bank can be utilized by means of trenches, if necessary, though the quantity of sewage that can be disposed of in this way would be considerably less per acre than upon the filter beds. It is proposed to prepare in the beginning four of the filter beds shown upon the plan, aggregating about 1.5 acres in area, and this area should provide for the diposal of the sewage of the present village for several years after sewers are introduced.

On account of the comparatively small elevation of the filter beds above the level of the water in the river, their operation may be interfered with occasionally by freshets; but no serious trouble is to be anticipated from this cause if no change is made such as would permanently raise the level of the water in the river above its level as found at the time of the surveys.

TAUNTON. The Board received an application from the sewer commissioners of Taunton, Nov. 5, 1895, for advice relative to the disposal of the sewage of Taunton into the Taunton River without purification.

On March 5 a hearing was held at the office of the State Board of Health pursuant to a notice, at which the authorities of the city of Taunton and of the towns of Berkley, Dighton and Somerset were represented, the latter being opposed to the disposal of crude sewage of the city into the Taunton River. The hearing was continued and concluded on March 20, and on March 24 the Board sent the following reply to the sewer commissioners of Taunton: —

BOSTON, March 24, 1896.

The State Board of Health has considered your application with reference to the disposal of the sewage of the city of Taunton, and, before advising you definitely with reference to the most appropriate method of disposing of the sewage of the city, requests that you furnish an alternative plan for the disposal of the sewage by filtration through sand upon a suitable area available for the purpose.

On May 11 the sewer commissioners replied, suggesting the purchase of a certain tract or tracts of land in Berkley, near the Taunton River, for the purpose of using them as filtration areas for the sewage of the city. To this application the Board replied as follows: —

BOSTON, June 6, 1896.

In response to a request of this Board, dated March 24, 1896, that you submit a plan providing for the disposal of the sewage of Taunton on land, thus completing the plan of sewage disposal as proposed in the report accompanying your original application, this Board received from you, on May 11, a communication stating that you proposed to use land bordering on the Taunton River, opposite Blake's landing, and subsequently received from you a plan of the land, showing its outline and general elevation above high water in the river.

The Board has carefully considered the plan submitted, and has caused an examination of the land to be made by its engineers, and samples of the soil from a limited number of test pits located in various parts of the area to be analyzed.

These examinations indicate that there is an area of about 55 acres here having a sandy soil, which is situated at a sufficient elevation above average high water in the river to allow for underdrainage.

The information furnished by the limited number of test pits indicates that the soil of this area is generally very fine, and is composed of layers

of varying degrees of fineness, — a condition which would be unfavorable to the thorough aeration of the filter beds. A portion of the area, amounting to perhaps a third of the whole, contains a somewhat coarser sand, which is much better adapted to the purification of sewage.

The area as a whole will require a very large amount of preparation in order to bring it into suitable condition for the disposal of the sewage of Taunton by intermittent filtration. There is a considerable depth of loam upon the surface, which it will be necessary to remove, and a thorough system of underdrainage will be required. With thorough preparation and proper care of the filter beds, however, it is possible that the sewage of the city could be disposed of here for a time, unless there is a more rapid extension of the sewerage system than you now anticipate; but the cost of preparing the filter beds would be very large, as compared with the cost of preparing beds for this purpose where the material is coarse and porous; and, moreover, it does not appear that there is any considerable area of land in the immediate vicinity that can be utilized when an additional area becomes necessary. The material found in test pits dug in the smaller lots south of this area, plans of which were subsequently submitted, was found to be extremely fine, indicating that no considerable amount of sewage could be disposed of by filtration upon these lots.

There being much doubt as to the capacity of the proposed filtration area for the disposal of the sewage of the city of Taunton for a reasonable time in the future, and considering the large probable cost of properly preparing the filter beds, it seems very desirable that a much more thorough investigation be made of that part of your proposed plan which relates to the disposal of the sewage of the city upon land.

In view of all the circumstances, the Board does not, at present, approve of the proposed plan for the disposal of the sewage of Taunton, but advises a further investigation of the subject. In making these investigations, it is desirable that you determine, first, whether there is not some suitable area within the limits of the city of Taunton upon which it may be feasible to dispose of the sewage by intermittent filtration at a reasonable cost. If such an area cannot be found within the limits of the city, territory outside of the city limits should be considered, with a view to discovering some area suitable for the disposal of the sewage, which would not be objectionable if used for this purpose.

Should one or more suitable areas be found, a careful estimate should be made of the probable cost of preparing filter beds and disposing of the sewage upon them.

The Board will assist you, so far as it can, in these investigations, if you desire, and will make such examinations of filtering materials as may be necessary.

The sewer commissioners, on June 25, submitted a further plan for filtering the sewage of the city on land above the city and near the Taunton River. The Board replied to this communication as follows: —

BOSTON, July 6, 1896.

The State Board of Health received from you, on June 26, a communication setting forth in a general way a proposed system of sewerage and sewage disposal for the city of Taunton, accompanied by a plan showing a location for a pumping station on the north-easterly side of the New Bedford branch of the New York, New Haven & Hartford Railroad, between Ingell Street and the Taunton River, and a line of force main leading from the pumping station to a filtration area situated near the Taunton River, about a mile above the filter basin and pumping station of your water works.

A plan of the proposed filtration area was also received, showing an area of 65 acres, situated on the left or southerly bank of the river, just below the point where it is joined by the Cotley River. Other areas in the vicinity which might be made available for sewage-disposal purposes were indicated by your engineer.

By the present plan, it is understood that it is feasible to collect at the proposed pumping station the sewage from all of the thickly settled portions of the city, including the low districts near the river, which were omitted from the system proposed by the previous plan.

The Board has caused an examination of the proposed filtration area to be made, and samples of material taken from test pits in various parts of the area to be analyzed. The results of these examinations show that the material is for the most part well suited for the disposal of sewage by intermittent filtration, and there are other areas of land in the vicinity which also appear to be composed of porous material, judging from the appearance of the surface, which could be used for sewage-disposal purposes if necessary, so that it appears that a sufficient area of suitable land could probably be made available in this vicinity for the disposal of the sewage of the city of Taunton; but the situation of the proposed filtration area near the river, a short distance above the filter basin of the Taunton water works, is such that this Board cannot approve of the use of this area for sewage-disposal purposes so long as the effluent mingled with river water may be drawn through the filter basin of the water works for supplying the city with drinking water.

On August 18 the sewer commissioners again wrote to the Board, proposing to build a drain to convey the effluent away from the

water works to a point farther down the river, and to construct an impervious dam between the filtration area and the river. To this communication the Board replied as follows: —

BOSTON, Sept. 10, 1896.

The State Board of Health received from you, August 20, a communication stating that you have made a more thorough examination of the proposed filtration area near Williams Street, and that you are satisfied that you can construct filter beds in such a manner that, by building a drain from the filtration area to the Taunton River, about 2 miles below the water works pumping station, you can be sure that none of the effluent can possibly reach the basin of the water works. You propose to construct the beds and to dispose of all of the drainage from the filtration area in this way. You state that an examination of the materials near the bank of the river along the filtration area shows that you can construct an impervious dam at this place.

Plans showing contour lines upon the proposed filtration area and the proposed line of the drain from the area to the Taunton River, with profile, were received with the application.

The Board has considered this plan, and concludes that, if all of the effluent can be removed from the proposed filtration field to a point of discharge in the Taunton River sufficiently below the water works filter basin to insure that no effluent can be drawn into the basin, and if the proposed dam can be so constructed as to prevent effluent or unfiltered sewage from entering the river otherwise than through the proposed drain, the sewage of the city of Taunton might be satisfactorily disposed of upon the area proposed; but no plans are furnished to show the method by which it is proposed to prevent the effluent from reaching the river opposite the filter beds. The Board, therefore, requests that you submit sufficient details of the scheme to show the character of the layers of material at the site of the proposed dam, and how you propose to construct the dam to make it impervious, and what method will be adopted to prevent accidental overflow of the sewage from the filtration area into the river above the water works filter basin. It is desirable also that you show the character of the layers of material underlying the proposed filter beds and the plan of the proposed underdrain system.

VAN CHOATE ELECTRIC COMPANY (FOXBOROUGH). The Van Choate Electric Company of Foxborough submitted to the Board for its approval, March 7, 1896, a plan of sewage disposal for their factory, having an outlet into a tributary of Mumford River. The Board replied to this application as follows: —

BOSTON, April 22, 1896.

The State Board of Health received from you, on March 7, an application for advice with reference to a proposed system of sewage disposal for the works of the Van Choate Electric Company, accompanied by a plan of a proposed settling tank and filter, having an outlet into a small brook, a tributary of the Mumford River.

The essential features of the plan are a settling tank for the removal of suspended matters from the sewage by sedimentation, and a filter bed 75 feet in length, 25 feet in width and 4 feet in depth, to be composed of stones and coarse gravel held between stone walls laid without mortar, through which sewage is to be passed laterally from an inlet chamber along one side of the bed to an effluent chamber on the opposite side, discharging thence into the brook. Sewage is to enter the inlet chamber through a pipe 4 feet above the bottom of the filter. Fourteen lines of 4-inch tile pipe are indicated upon the plan submitted, running from the inlet chamber on a level just below the pipe through which sewage enters it, across the filter, and terminating in the stones on the opposite side. It is proposed to lay these pipes with open joints, so that when sewage flows through them it may find an outlet into the filter in this way. It is understood that as many as 3,000 operatives may be employed in the works for which this system of sewage disposal is proposed.

The Board has carefully considered the plan submitted, and finds that it would be impracticable to purify the sewage from any considerable number of operatives by this plan.

The attention of the Board has been called to a filter constructed upon a plan similar to that proposed in the application submitted and intended to purify the sewage of a factory in Norwood. The results of a chemical analysis of a sample of the sewage applied to this filter and of a sample of the effluent show that no material purification of the sewage takes place in its passage through the filter; and, as the size of the filter proposed for the Van Choate Electric Company in proportion to the number of operatives would be about the same as at the Norwood works, there is no reason to expect that the results would be any different with the proposed filter than with the existing filter at Norwood.

The Board would therefore advise that you have a further investigation made, with a view to disposing of the sewage from your works in such a manner that it will not pollute the stream into which the effluent is finally discharged.

WESTBOROUGH INSANE HOSPITAL. The trustees of the Westborough Insane Hospital submitted a plan for the disposal of the

sewage of that institution to the Board, April 7, 1896. This plan provided for the disposal of the sewage of the institution by filtration upon an area of land about a half mile from the hospital. The Board replied to this application as follows: —

BOSTON, May 7, 1896.

The State Board of Health received from you, on April 7, 1896, a plan for a proposed system of sewage disposal for the Westborough Insane Hospital. The plan provides for collecting the sewage of the hospital in a receiving basin or reservoir to be located about 250 feet north-west of the nearest portions of the buildings, from which an iron pipe sewer in the form of an inverted siphon is provided, to convey the sewage to a filtration area on the southerly side of Little Chauncy Pond, and about half a mile from the hospital buildings. Before entering the receiving reservoir the sewage will pass through a sludge tank intended for the removal of a portion of the solid matters from the sewage by sedimentation, and provision is made whereby the sludge can be drawn off from this tank by gravity and used as a fertilizer. The receiving reservoir will have a capacity of 20,000 gallons, and is designed to discharge its contents automatically, at intervals of several hours.

The area selected for the disposal of the sewage is the one referred to in previous communications of this Board as an area well adapted to the disposal of the sewage of this institution by intermittent filtration.

The Board has carefully considered the plan submitted, and has caused an examination of the proposed filtration area to be made by one of its engineers, and concludes that the proposed plan will provide satisfactorily for the disposal of the sewage of the hospital.

The screens indicated upon the plan have a somewhat limited area, but it is understood that your engineer proposes to provide larger screens than are indicated, and a larger screen area is very desirable, to avoid the necessity of excessive attention to keep them from clogging.

WHITMAN. The selectmen of Whitman applied to the Board, Aug. 13, 1896, for its advice relative to a system of drainage for Whitman, having a portion of its outlets into Hobart's Pond in that town. The Board replied to this application as follows: —

BOSTON, Nov. 5, 1896.

The State Board of Health received from you, on August 13, an application giving notice of your intention to introduce a system of drainage in the town of Whitman, accompanied by plans showing existing drains and

a proposed system of drainage for the remainder of the thickly settled portion of the town.

The Board has carefully examined the plans submitted, and has caused an examination of the territory to be made by one of its engineers. The sizes of the proposed drains appear to be adapted to remove the surface and ground water from the watersheds which they are designed to serve, and the places of discharge of most of the drains are satisfactory. Two of the proposed drains, however, — one in Essex Street and another passing through Alden Street, — and one of the drains already built, which takes the drainage from the portion of the town in the vicinity of the junction of Temple and Washington streets, have outlets into Hobart's Pond. The water supply of Whitman is taken chiefly from a filter gallery upon the shore of the pond, and the Board is informed that the quantity furnished by the filter gallery is not at all times sufficient for the supply of the town, and the water is sometimes drawn directly from the pond.

While the drains are designed for surface water only, and are not intended to receive sewage, yet the experience with similar drains in thickly populated districts, especially where there is no sewer system, has shown that there is danger that unpurified sewage may find its way from cess-pools or from other receptacles for sewage or refuse matter into the drains and thence into the water supply of the town.

The Board is of the opinion that there is danger that the drainage discharged from these drains may be of such a kind as will corrupt or impair the quality of the water of the pond, upon the shore of which your filter gallery is situated and from which a part of your supply is taken directly, contrary to the provisions of chapter 80, section 96 of the Public Statutes.

Under existing conditions, the Board cannot advise the adoption of the portions of the proposed plan which provides for the discharge of drainage into Hobart's Pond or its tributaries, and advises that the matter be given further consideration, with a view to providing for the disposal of the drainage in such a manner that it cannot have an unfavorable effect upon the quality of your water supply.

Pollution of Ponds and Streams.

The following is the substance of the action of the Board relative to applications and information received in relation to the pollution of streams and ponds during 1896: —

Bradford. The water commissioners of Bradford applied to the Board, July 10, 1896, for its advice relative to the danger of pollution of their water supply in consequence of the existence of dwell-

ing-houses on the shores of Johnson's and Chadwick's ponds, and the best mode of preventing it. The Board replied to this application as follows: —

BOSTON, Aug. 6, 1896.

Attention was especially called to drainage from houses on the shore of an arm of the pond, a short distance above the dam at its outlet. An examination of the conditions here shows that drainage from several houses is discharged directly into the pond. Water from the pond is used by the mills upon the stream below, and under ordinary conditions pollution discharged into this arm of the pond is drawn out with the water used by the mills, and at such times there is no danger of the pollution of the water supply of the town of Bradford by sewage from these houses. At times when no water is being drawn by the mills, there may be danger that pollution discharged into this arm would find its way into the main portion of the pond.

While danger to the purity of your water supply from this cause is remote, the Board considers that it is desirable to avoid it, if possible. This can be done either by diverting sewage from the houses in question to a point of discharge below the dam, or by causing a constant stream of water to flow out of the pond at all times sufficient to maintain a current from this portion of the pond toward the dam. It is understood that you have already taken action to prevent the threatened pollution from the summer residences within the watershed of Johnson's Pond.

IPSWICH. The water board of Ipswich applied to the Board of Health, April 25, 1896, for the advice of the Board relative to the best method of protecting its water supply from pollution in consequence of the existence of certain houses and stables on its immediate watershed. The Board replied to this application as follows: —

BOSTON, May 5, 1896.

The State Board of Health received from you, on April 25, an application for advice with reference to the protection of the purity of Dow's Brook Reservoir, your present source of water supply, from pollution by houses and barns located near the reservoir.

The Board has caused an examination of the locality to be made by one of its engineers, and finds that there are about nine houses and several stables situated within a short distance of the reservoir, drainage from which may enter the reservoir either directly or through small water courses in the vicinity of some of the buildings, and in some cases drains were found conveying household or stable drainage directly into the reser-

voir or a tributary water course. The soil in this region appears to consist largely of clay, and polluting matters discharged or deposited on the ground may flow or be carried by rain into the reservoir or the water courses near by, the nature of the soil being such that water does not penetrate it readily.

The Board is informed that there are cases of typhoid fever in some of the houses near the reservoir, and, as drainage or sewage from these houses may find its way into the reservoir with considerable directness, people using water drawn from the reservoir for drinking are exposed to very serious danger of infection with typhoid fever.

In a communication to the town of Ipswich relative to the use of Dow's Brook as a source of water supply, dated Feb. 1, 1894, the Board called attention to the danger of pollution of the water by the farm-houses upon the watershed of the proposed reservoir, and advised that care should be taken to prevent any pollution of the water by these farm-houses. The Board urges you to proceed at once to prevent the further pollution of the reservoir from this cause by diverting all sewage and other objectionable drainage from these buildings away from the reservoir and its tributaries, and disposing of it in some suitable manner, where it will not endanger the purity of your water supply.

The polluting matter which at present enters the reservoir tends to promote growths of organisms in the water by providing food upon which these organisms may subsist, and the removal of this pollution will tend to improve the character of the water in this respect also.

MANCHESTER. The selectmen of Manchester, being directed by the town to report upon the best method of improving the condition of Central Pond in Manchester, and a plan having been reported to the town for cleaning out the pond and depositing the material so removed behind a retaining wall to be built for the purpose, submitted the question to the State Board of Health for its advice, Oct. 7, 1896. The Board replied to the application as follows: —

BOSTON, Nov. 9, 1896.

The pond in question is located in the central village of Manchester, and is formed by a dam at the mouth of Sawmill Brook. The dam is provided with a gate by means of which the pond can be emptied at low tide. Owing to leakage past the dam, it is said to be difficult to keep the pond full of water in the drier months of the year, and portions of the shore and bottom are consequently exposed at times.

The Board has caused an examination of the pond and its surroundings to be made by one of its engineers, at a time when the water was drawn off

so that the condition of the bottom could be seen. It appears that the sewage from about sixteen buildings, including a small hotel and a stable, is discharged directly into the pond, and the bottom is covered with a thick layer of mud and organic matter, a portion of which has evidently come from the sewers and drains.

It is said that the pond gives off an offensive odor in the summer time, particularly when the bottom and shores are partially exposed, and that bubbles of gas rise to the surface of the water from the decomposing material upon the bottom.

By constructing a wall around the shores and cleaning the bottom of the pond, as proposed, a partial and temporary improvement in its condition would be made; but, in the opinion of the Board, to effect any permanent improvement in the sanitary condition of the pond, it is essential that the discharge of sewage into it, or any channel leading to it, be discontinued. After the sewage has been diverted and the mud and organic matter removed from the bottom, there is still some question whether so shallow a pond can be kept in unobjectionable condition in the midst of the village without frequent repetition of the cleaning process, and if the pond is to be preserved, it may be desirable to devise some means of flushing it out occasionally.

It is desirable that the pond be kept full of water at all times, and until the discharge of sewage into the pond is prevented and the organic matter removed from its bottom, some relief from offensive odors may be obtained by keeping the pond full, but the sewage should be diverted as soon as practicable.

The most favorable time for removing the organic matter from the bottom of the pond, in order that it may give the least offence to those living in the neighborhood, would be during the cooler weather of the fall and in the winter months.

The Board would also advise that, in providing a system of sewerage and sewage disposal for the buildings from which sewage is now discharged into the pond or its tributaries, you take into consideration the whole question of sewage disposal for the town, in order that any sewer or sewers constructed for the relief of this section may form a part of a general system for the village when such a system may be necessary.

North Adams. The board of health of North Adams applied to the Board, July 18, 1896, for its advice relative to the propriety of acquiring two farms situated on the watershed of the public supply, for the purpose of protecting the supply from pollution. The Board replied to this application as follows: —

BOSTON, Aug. 6, 1896.

The State Board of Health has considered your request for advice as to the acquirement of two farms and the buildings thereon within the watershed of Notch Brook by the city of North Adams, and has caused an examination of the premises to be made by one of its engineers.

The situation of the buildings upon these farms is such that the natural drainage is into the proposed storage reservoir of the city of North Adams, and with present conditions there is danger that the reservoir may be polluted by sewage from these farms. It is, therefore, desirable that the city control them in such a way as to prevent the danger of pollution of the waters of the reservoir.

While it is possible, by the construction of suitable vaults and cesspools, to greatly reduce the danger of contamination from these buildings, efficient inspection will be necessary to accomplish this result. By causing the abandonment of the buildings, all danger to the water supply will be removed, and this is the best method of preventing danger to your water supply.

NORTHFIELD. The selectmen of Northfield applied to the Board, Nov. 12, 1896, for its advice relative to protecting the water of Mill Brook in that town from pollution. The Board replied to this application as follows: —

BOSTON, Dec. 10, 1896.

The State Board of Health received from you, on November 12, an application with reference to the protection of the purity of the waters of Mill Brook, so-called, in the town of Northfield, a stream which is used by several families as a source of domestic water supply, and has caused an examination of the locality to be made by one of its engineers.

From this examination it was found that sewage from the Northfield Hotel and from houses in the vicinity was entering the brook in such a way as to endanger the health of persons using the water for domestic purposes. The pollution of the stream by these houses could be prevented by diverting the sewage so that it would not enter the stream above the point from which water is taken for domestic purposes, or by disposing of it upon land, if a suitable place of disposal can be found in the vicinity, or in some other suitable way.

Farther up stream there are many houses situated near the stream, and in order to insure the suitability of the water for domestic purposes it will be necessary to make such provisions for the disposal of the sewage of these premises that no sewage may enter the stream.

The local board of health can prevent this pollution, if satisfied that

the present condition of the stream is a danger to the health of those using it.

Unless effective measures are taken to prevent all sewage from entering the stream, it cannot be regarded as a safe source of water supply for domestic purposes.

PEABODY. The water commissioners of Peabody applied to the Board, March 4, 1896, for advice relative to the question of taking certain land lying upon the watershed of one of their reservoirs, for the purpose of protecting the purity of the water. The Board replied to this application as follows: —

BOSTON, April 2, 1896.

The State Board of Health received from you, on March 4, 1896, an application for advice with reference to protecting the purity of the water of the reservoir below Spring Pond, used as the direct source of water supply of Peabody, accompanied by a plan of a tract of land on the westerly side of the reservoir, which you state has recently been bought by a company and divided into lots which it is the intention of the company to sell for building purposes. The land in question lies between Lynn Street and the reservoir, and its general slope is from Lynn Street toward the reservoir. About half-way between the street and the reservoir, however, there is a small brook which flows northerly in the vicinity of the proposed Woodland Street, and discharges below the reservoir. Close to the easterly side of the brook there is a slight rise which forms a divide between the brook and the reservoir, and from this divide the land slopes directly to the reservoir.

Should houses be built upon the tract of land between Lynn Street and the brook, the surface drainage from this area would naturally flow off in the brook and be discharged below the reservoir; but drainage from the area between the brook and the reservoir would naturally flow directly to the reservoir. It would, therefore, be advisable for the town to control at least all land between the brook and the reservoir, to prevent the use of this area for any purpose that would tend to injure the quality of the water supply of the town; and the channel of the brook should be kept permanently open and its waters allowed to discharge as at present, below the reservoir. The desirability of controlling the land between the brook and Lynn Street depends largely upon the character of the soil and the direction in which the ground water flows, concerning which no information is available to the Board. If the soil is coarse and porous, and the ground water from this tract finds an outlet into the reservoir, the sewage deposited upon this territory might filter into the ground and find its way to the reservoir, and be objectionable.

WALPOLE (Neponset Reservoir). A communication was received from Uriah W. Boyden of Walpole, Feb. 7, 1896, remonstrating against the proposed discharge of sewage from the Van Choate Electric Works of Foxborough into the Neponset Reservoir. The Board replied to this communication as follows: —

BOSTON, March 6, 1896.

The State Board of Health has considered your communication with reference to the pollution of the Neponset Reservoir in Foxborough by sewage from the Van Choate Electrical Manufacturing Company's works, and has caused an examination of the premises to be made.

It is found that, while a drain for the removal of surface and ground water from the vicinity of the buildings has already been dug to the Neponset Reservoir and the construction of a sewage-disposal plant begun, the buildings are not yet completed and are not expected to be ready for occupancy until next fall, so that no sewage is at present being discharged from the works, and none is likely to be discharged for several months.

The attention of the company has been called to the provisions of chapter 375 of the Acts of 1888, a copy of which is enclosed.

WILLIAMSTOWN. The attention of the Board was called to the fact that a certain dwelling-house in Williamstown was so situated upon the watershed of the water supply of the town as to constitute a menace to the consumers of the water. The Board, therefore, sent the following letter to the Williamstown Water Company: —

BOSTON, Nov. 13, 1896.

It has been brought to the attention of the Board that there is a dwelling-house situated near the Flora Glen Reservoir, so-called, one of the sources of water supply of Williamstown, which is a menace to the purity of the water. The dwelling-house in question is located within 60 feet of the reservoir, and the arrangements are of such a character that a single case of typhoid fever occurring in this house might at any time, and before the danger was recognized, seriously endanger the health of the people of Williamstown.

While it appears that no water has been used from this reservoir for the supply of the town since last August, and that water is not likely to be used from it again until next summer, the Board would nevertheless urge that the house in question, together with any outbuildings within the watershed of the reservoir be removed without delay to some place outside of the watershed, and that any sewage or refuse matter that may have been deposited upon the ground about the buildings or at any place where there

is danger that it may find its way into the reservoir be carefully removed, so that the water from this reservoir may with safety be supplied to the town at all times.

WRENTHAM (PLAINVILLE). Messrs. Lincoln, Bacon & Co. of Plainville applied to the Board, Nov. 5, 1895, for its advice relative to the most practicable method of preserving the purity of the water of Bacon's Pond, the source of water supply of the village. The Board replied to this application as follows: —

BOSTON, March 6, 1896.

The State Board of Health received from you an application for advice as to the most practicable method of preserving the purity of the waters of Bacon's Pond, so-called, in the village of Plainville, from which water is drawn for the supply of the inhabitants of the village for domestic purposes. You state that the town of Wrentham has recently constructed a sewer on South Street in Plainville, which empties into Bacon's Pond, and is believed to be an injury to the quality of the water supply.

The Board has caused an examination of Bacon's Pond and its vicinity to be made by one of its engineers, and finds that the condition complained of is caused by the construction of a culvert to convey the drainage from the east side of South Street to the west side, from which it flows into Bacon's Pond. It appears also that a culvert formerly existed at this place, but it is said to have become obstructed before the reconstruction of the road, which took place last year. Water from the east side of South Street has probably always found its way into Bacon's Pond, either through the old culvert or by flowing over the street, and no material change has consequently been made in the conditions which formerly existed.

The watershed of Bacon's Pond contains a large population, and many of the houses are in the immediate vicinity of the pond. In the opinion of the Board, the danger of pollution entering the pond and the stream which feeds it from the population upon the watershed makes the water of the pond unsafe for drinking.

It is feasible to divert the water from the culvert into the outlet of the pond, whereby its drainage area would be reduced and the drainage from a considerable number of the houses on the watershed would be diverted to the stream below. There would still remain, however, a large population on the watershed of the pond; and, in the opinion of the Board, the diversion of the water conveyed by this culvert into the stream below would not render the pond a suitable source of supply for domestic purposes, on account of the large population which would still remain upon its watershed.

Examination of Water Supplies.

EXAMINATION OF WATER SUPPLIES.

EXPLANATORY NOTE.

The systematic examination of the water supplies of the State was begun June 1, 1887, and has been continued up to the present time. The results of the investigations made during the first two years were published in a special report of the Board upon the Examination of Water Supplies (1890), and of those made during succeeding years in the annual reports of the Board beginning with the 1890 (Twenty-second Annual) report.

The special report contains a description of each of the water supplies in the State existing at the date of that report, and the annual reports contain descriptions of new works and changes in existing works.

In all of these reports an alphabetical arrangement by towns has been adopted. Sources of water supply are tabulated under the name of the town supplied, other waters under the name of the town in which they are situated. The analyses of water from the larger rivers not used as sources of water supply are given in a subsequent tabulation, headed "Examination of Rivers."

The method of making the chemical examinations remains unchanged, and the results are presented in the tables of this report in the same form as in the last one.

The samples of water are usually received at the laboratory from twenty-four to forty-eight hours after collection. All surface water and such samples of ground water as contain suspended matter are filtered through filter-paper before determining the color, the residue on evaporation and the albuminoid ammonia in solution. Some ground waters which are perfectly clear and colorless when drawn from the ground become turbid and colored on standing, in consequence of the oxidation of the iron which they contain. In these waters the residue on evaporation is determined without filtration, since this iron is an essential and not an accidental ingredient in the water. In the changes which accompany the oxidation of the iron in waters of this character, they become first cloudy (well described by the word *milky*) and finally deposit a precipitate of oxide of iron. In the cloudy condition they have a distinct color, which, while it does not have the same significance as in the case of surface waters, and is only a passing phenomenon, is, nevertheless, of interest as showing a color which the water may assume while the oxidation of the iron is in progress. When the iron is all oxidized and precipitated the water may become colorless again. In some cases, however, the iron occurs in combination with organic matter, forming a much more stable body. In such cases the water is of a brown color when first drawn from the ground, and, while the iron begins to oxidize soon after the water is exposed to the air, the process goes on slowly and the water may remain colored and iron continue to precipitate for a long time. Explanatory notes will be given in connection with the tables of analyses for waters containing iron.

The color of water is expressed by numbers which increase with the amount of color. The standard used is nesslerized ammonia, as described on page 531 of the

Special Report upon the Examination of Water Supplies, 1890, and on page 329 of the Annual Report for 1892. Boston water, as drawn from a tap at the Institute of Technology, had an average color in 1896 of 0.49. Other water supplies in the State have had an average color of from 0 to 1.34.

In cases where examinations of a source have been made with regularity for several years, the averages of the chemical analyses of each year are given.

There was no change in the method employed in the microscopical examination of water between Nov. 6, 1890, and Dec. 1, 1895. The method employed between those dates is fully described in the Twenty-third Annual Report of the Board for the year 1891 (pages 395–421). Before Nov. 6, 1890, the methods employed were less perfect, so that a smaller proportion of the total number of organisms present in the water was separated from it and observed under the microscope; and, before drawing conclusions from a comparison of the microscopical examinations of waters made before and after this date, the explanatory note on page 70 of the Twenty-second Annual Report for 1890 should be read.

Since Dec. 1, 1895, the method for the microscopical analysis of water has been considerably improved by discarding the ordinary glass funnels previously employed, and substituting funnels which have been constructed with stems of equal calibre, to give equal rates of filtration, and with steeper sides, so that those organisms which are of a gelatinous character will be less liable to adhere to the sides of the funnel. By the use of these funnels variations in the numbers of organisms found, which may be caused by dissimilar slopes of the sides of the funnels and unequal rates of filtration, are avoided.

To indicate the amount of the so-called *Zoöglœa* observed, the number of individual masses is not counted, but an area equal to 2,500 square microns, or .0025 square millimeters, has been adopted as an arbitrary unit.

In publishing the results of the microscopical examinations the same system is followed as last year. The plants observed are classified in four groups, viz.: Diatomaceæ, Cyanophyceæ, Algæ and Fungi. The animals observed are grouped as Rhizopoda, Infusoria, Vermes and Crustacea.

The names of the different genera in each group are given with the numbers of each per cubic centimeter, except that, to avoid making the tables excessively long, they are omitted when present only in very small numbers. It is not feasible to make with regard to omissions a single rule which will apply to all cases, because it is desirable to include smaller numbers of animals than of plants, and of the larger animals than of animals generally. Moreover, there are exceptional cases in which it is desirable to indicate the presence of even very small numbers of the more important plants or animals. Two general rules, however, have been adopted in printing the results, viz.: —

1. All genera of plants are included in which the total number observed averages as much as 0.5 per cubic centimeter per month.

2. All genera of animals are included in which the total number observed averages as much as 0.1 per cubic centimeter per month.

The larger microscopic animals, such as some of the Crustacea, are included, even when present only in very small numbers.

Fractions are generally omitted from the table, the nearest whole number of organisms per cubic centimeter being given. Where the number observed is 0.5 or less, the fact that the organism was present is usually indicated by the abbreviation "pr.," but in the case of the larger organisms very small fractions are given.

EXAMINATION OF WATER SUPPLIES.

WATER SUPPLY OF ABINGTON AND ROCKLAND.

Chemical Examination of Water from Big Sandy Pond, Pembroke.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15914	Jan. 20	Slight.	Slight.	.10	3.00	1.30	.0016	.0182	.0162	.0020	.68	.0030	.0000	.23	0.5
16434	Apr. 16	Slight.	Slight.	.08	2.75	1.20	.0000	.0128	.0118	.0010	.64	.0070	.0000	.19	0.3
16961	July 12	Slight.	Slight.	.13	3.15	0.65	.0002	.0144	.0130	.0014	.65	.0000	.0000	.31	0.3
17541	Oct. 13	Slight.	Slight.	.10	3.00	0.75	.0000	.0198	.0166	.0032	.70	.0030	.0000	.26	0.3

Averages by Years.

-	1887*	-	-	.20	3.46	0.94	.0008	.0150	-	-	.58	.0056	-	-	-
-	1888†	-	-	.11	3.21	0.83	.0006	.0170	-	-	.57	.0075	.0001	-	-
-	1892‡	-	-	.10	4.30	-	.0000	.0200	.0150	.0050	.59	.0090	.0000	-	0.5
-	1893	-	-	.07	3.19	1.19	.0010	.0146	.0122	.0024	.63	.0012	.0000	.21	0.5
-	1894§	-	-	.04	2.75	1.00	.0003	.0131	.0109	.0022	.62	.0050	.0000	.17	0.2
-	1895‖	-	-	.13	2.97	0.90	.0013	.0165	.0151	.0014	.66	.0017	.0000	.27	0.7
-	1896	-	-	.11	2.97	0.97	.0004	.0163	.0144	.0019	.67	.0032	.0000	.25	0.3

* June to October, six samples. † January to April, five samples. ‡ March.
§ March and April. ‖ February, March and April.

NOTE to analyses of 1896: Odor of the first sample, none, becoming distinctly vegetable and grassy on heating; of the second, none; of the third, distinctly vegetable and grassy; of the fourth, faintly vegetable and mouldy.—— The samples were collected from a faucet at the pumping station.

Microscopical Examination.

The total number of organisms per cubic centimeter found in each sample was as follows: No. 15914, 61; No. 16434, 269; No. 16961, 28; No. 17541, 534.

ACTON.

The advice of the State Board of Health to the town of Acton with reference to taking water for a public water supply from the ground in the westerly part of the town may be found on pages 9 and 10 of this volume. Analyses of samples of water collected from test wells in this locality may be found on page 78 of the annual report for 1895.

The advice of the Board to citizens of East Acton with reference to taking water for the supply of that village from the water works of the town of Concord may be found on page 10 of this volume.

WATER SUPPLY OF ADAMS FIRE DISTRICT, ADAMS.

In 1895 a contract was made with the Adams Power Company to furnish an auxiliary supply of water to the Fire District from tubular wells situated at the Zylonite Works in the valley of the south branch of the Hoosac River, below Adams. Water from this source is pumped directly into the distributing system at times when the yield from the other sources is insufficient for the supply of the town. An analysis of a sample of water from one of these wells may be found on page 81 of the annual report for 1895.

Chemical Examination of Water from Bassett Brook Reservoir, Adams.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hard[illegible]
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16127	Feb. 24	None.	V. slight.	.02	3.00	0.35	.0016	.0035	.0030	.0005	.07	.0260	.0000	.06	1.9
16479	Apr 25	None.	Slight.	.05	2.40	0.50	.0095	.0048	.0036	.0012	.08	.0130	.0000	.12	1.7
16844	June 20	None.	V. slight.	.05	3.70	0.90	.0000	.0044	.0034	.0010	.10	.0100	.0000	.14	2.5
17286	Aug. 25	None.	V. slight.	.02	5.40	0.80	.0000	.0032	.0018	.0014	.06	.0180	.0000	.06	3.8
17734	Oct. 27	None.	None.	.05	2.95	0.85	.0002	.0064	.0050	.0014	.08	.0070	.0000	.17	1.7
18193	Dec. 28	None.	V. slight.	.02	3.70	1.00	.0000	.0024	.0020	.0004	.10	.0350	.0000	.09	2.4

Averages by Years.

-	1887*	-	-	.07	4.12	0.67	.0011	.0075	-	-	.06	.0128	-	-	-
-	1890†	-	-	.00	2.90	-	.0000	.0040	-	-	.10	.0350	.0000	-	1.9
-	1895‡	-	-	.05	4.95	0.50	.0000	.0045	.0040	.0005	.09	.0365	.0000	.14	3.0
-	1896	-	-	.03	3.52	0.70	.0004	.0042	.0031	.0011	.08	.0165	[illegible]	.11	2.3

* June to December. † May. ‡ April and September.

NOTE to analyses of 1896: Odor of the first sample, distinctly unpleasant; of the others, none.—No. 17286 was collected from the reservoir; the other samples were collected from a faucet supplied with water from the reservoir.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

ADAMS.

Chemical Examination of Water from Dry Brook Reservoir in Adams and Cheshire.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16128	Feb. 24	V. slight.	Slight.	.25	5.35	1.40	.0002	.0078	.0068	.0010	.06	.0220	.0000	.29	3.5
16478	Apr. 25	Slight.	Slight.	.53	4.95	1.40	.0022	.0128	.0110	.0018	.07	.0080	.0000	.45	2.5
16843	June 20	None.	Slight.	.25	7.95	1.65	.0002	.0098	.0084	.0014	.06	.0050	.0000	.36	6.0
17285	Aug 25	V. slight.	Slight.	.20	9.25	1.70	.0004	.0100	.0084	.0016	.08	.0070	.0000	.35	6.6
17735	Oct. 27	None.	Slight.	.35	7.05	1.60	.0018	.0168	.0146	.0022	.08	.0020	.0001	.49	5.1
18194	Dec. 23	None.	V. slight.	.17	7.10	1.50	.0000	.0050	.0048	.0002	.10	.0220	.0000	.26	4.9

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1887*	-	-	.24	7.50	1.29	.0012	.0111	-	-	.09	.0068	-	-	-
-	1895†	-	-	.21	8.90	1.15	.0002	.0101	.0073	.0028	.08	.0035	.0000	.34	6.0
-	1896	-	-	.26	6.94	1.54	.0008	.0104	.0090	.0014	.07	.0110	.0000	.37	4.8

* June to December. † May and September.

NOTE to analyses of 1896 · Odor, none. —— The samples were collected from a faucet supplied with water from the reservoir.

Microscopical Examination.

An insignificant number of organisms was found in each of these samples.

WATER SUPPLY OF AMESBURY. — POWOW HILL WATER COMPANY.

Chemical Examination of Water from Tubular Wells supplying Open Basins near Main Street.

[Parts per 100,000.]

Number	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
17176	Aug. 11	Distinct, milky.	Slight.	.10	9.40	.0000	.0012	.73	.0550	.0002	.03	3.2	.0190

Averages by Years.

Number	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1887*	-	-	.00	6.36	0006	.0058	.49	.0713	-	-	-	-
-	1888†	-	-	.00	6.09	.0004	0023	.43	.0720	.0001	-	-	-
-	1892‡	-	-	.01	6.65	0022	.0038	.51	1700	.0002	-	2.6	.0250
-	1893§	-	-	.00	6.90	.0000	.0034	.63	.1200	.0006	.06	2.2	0000
-	1894‖	-	-	.08	9.32	.0002	.0064	.55	0185	.0000	.03	4.2	0300
-	1895¶	-	-	.07	9.65	.0004	.0022	.59	.0600	.0000	.07	3.8	0200
-	1896	-	-	.10	9.40	.0000	.0012	.73	.0550	.0002	.08	3.2	.0190

* June to December. † January to May. ‡ May and August.
§ June. ‖ July and September, three samples. ¶ May and August.

NOTE to analysis of 1896: Odor, none. —— The sample was collected at the pumping station on Main Street.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

AMESBURY.

Chemical Examination of Water from Thirty-six Tubular Wells near Market Street.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
17177	Aug. 11	V. slight.	None.	.00	19.90	.0042	.0006	1.27	.0000	[illegible]	0.6	13.5	.0030

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1892*	-	-	.00	19.40	.0010	.0020	1.02	-	.0002	-	12.5	.0150
-	1893†	-	-	[illegible]	11.70	.0000	.0004	0.63	-	.0000	.02	6.4	[illegible]
-	1894‡	-	-	.03	19.95	.0028	.0007	1.22	.0010	.0001	.01	12.4	.0115
-	1895§	-	-	.02	20.70	.0028	.0008	1.02	[illegible]	.0000	.01	10.9	.0130
-	1896	-	-	.00	19.90	.0042	.0006	1.27	.0000	.0000	.06	13.5	.0030

* August. † June. ‡ July and September. § September.

NOTE to analysis of 1896: Odor, none. —— The sample was collected at the pumping station on Market Street.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

Chemical Examination of Water from Tubular Test Wells in Amesbury.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
17903	Nov. 18	V. slight.	Slight.	.01	8.80	.0006	.0012	.31	.0000	.0000	.00	4.5	.0150
17904	Nov. 18	Decided, milky.	V. slight.	.18	9.60	.0004	.0006	.34	.0000	.0000	.00	5.7	.0760

Odor, none. On heating, a faintly earthy odor was developed. —— The samples were collected from tubular test wells near Main Street in Amesbury, 2,000 feet south of the Main Street pumping station.

Microscopical Examination.

No organisms.

AMESBURY.

Chemical Examination of Water from Kimball's Pond, Amesbury.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	[illegible]														
17436	Sept. 11	Distinct.	Slight.	.28	3.60	1.85	.0016	.0200	.0182	.0018	.35	.0030	.0000	.41	1.1
17437	Sept. 11	Distinct.	Slight.	.28	3.90	1.45	.0010	.0210	.0170	.0040	.35	.0050	.0000	.42	1.1
17915	Nov. 18	Distinct.	Slight.	.37	4.30	1.95	.0004	.0214	.0188	.0026	.40	.0020	.0000	.56	1.6

Odor, faintly vegetable, and of the first sample also mouldy. —— The first sample was collected from the middle of the pond near the surface; the second, from the middle of the pond near the bottom; the third, from the pond near its outlet. This pond is not used as a source of public water supply.

Microscopical Examination.

No. 17436. Diatomaceæ, *Asterionella*, 4; *Diatoma*, 4, *Melosira*, 52; *Navicula*, 2; *Tabellaria*, 6. Cyanophyceæ, *Anabæna*, 38; *Clathrocystis*, 6; *Microcystis*, 80. Algæ, *Protococcus*, 16; *Staurastrum*, 2; *Staurogenia*, 212. Rhizopoda, *Actinophrys*, 4. Infusoria, *Dinobryon*, 2; *Mallomonas*, 2. Miscellaneous, *Acarina*, 10, *Zoöglœa*, 20. Total, 452.

No. 17437. Diatomaceæ, *Cyclotella*, 2; *Stephanodiscus*, 2; *Synedra*, 4; *Tabellaria*, 4. Cyanophyceæ, *Microcystis*, 28. Algæ, *Protococcus*, 16; *Staurogenia*, 16. Infusoria, *Codonella*, 4. Miscellaneous, *Zoöglœa*, 10. Total, 96.

No. 17915. Diatomaceæ, *Cyclotella*, 10; *Melosira*, 9; *Synedra*, 9; *Tabellaria*, 1. Cyanophyceæ, *Microcystis*, 1. Miscellaneous, *Zoöglœa*, 20. Total, 50.

WATER SUPPLY OF ANDOVER.

Chemical Examination of Water from Haggett's Pond, Andover.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15664	Jan 27	V. slight.	V. slight.	.23	3.30	1.35	.0010	.0146	.0130	.0016	.37	.0030	.0000	.36	1.6
16097	Apr 13	V. slight.	V. slight.	.23	3.15	1.35	.0000	.0124	.0122	.0002	.31	.0050	.0000	.33	1.1
16956	July 13	Slight.	Slight.	.15	3.65	1.40	.0006	.0170	.0146	.0024	.32	.0000	.0000	.34	1.2
17642	Oct. 13	V. slight.	Slight.	.09	2.90	0.75	.0004	.0158	.0140	.0018	.41	.0080	.0000	.30	1.3

Averages by Years.

-	1889*	-	-	.10	5.55	2.70	.0004	.0198	.0170	.0028	.29	.0040	.0001	-	1.1
-	1891†	-	-	.08	3.35	1.70	.0004	.0136	.0080	.0056	.33	.0030	.0000	-	1.3
-	1892	-	-	.08	3.20	1.02	.0003	.0175	.0147	.0028	.34	.0051	.0000	-	1.3
-	1893	-	-	.09	3.30	1.30	.0013	.0151	.0124	.0027	.34	.0020	.0000	.28	1.2
-	1894‡	-	-	.09	3.34	1.18	.0009	.0122	.0105	.0017	.34	.0020	.0000	.29	1.3
-	1895§	-	-	.15	3.55	1.18	.0021	.0149	.0133	.0016	.39	.0040	.0000	.30	1.6
-	1896	-	-	.17	3.25	1.21	.0005	.0149	.0134	.0015	.35	.0027	.0000	.33	1.3

* July. † November. ‡ January to April. § February, March and April.

NOTE to analyses of 1896: Odor of the first and last samples, none; of the second, faintly vegetable; of the third, distinctly unpleasant, becoming faintly vegetable on heating. —— The samples were collected from a faucet at the pumping station.

Microscopical Examination.

An insignificant number of organisms was found in each of these samples.

ARLINGTON.

Water Supply of Arlington.

Chemical Examination of Water from the Storage Reservoir of the Arlington Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
17143	Aug. 5	Cons., green.	Cons.	.70	7.65	3.40	.0004	.0842	.0370	.0472	.66	.0030	.0000	.68	1.7
17375	Sept. 8	Cons., green.	Slight, brown.	.42	8.40	4.60	.0000	.2430	.0468	.1962	.66	.0020	.0000	.76	2.2

Odor of the first sample, vegetable and sweetish; of the second, faintly sweetish, becoming stronger on heating. —— The samples were collected from the reservoir, near the gate-house.

Microscopical Examination.

No. 17143. Diatomaceæ, *Asterionella*, 5; *Melosira*, 28; *Synedra*, 40. Cyanophyceæ, *Anabæna*, 1,000; *Clathrocystis*, 480. Algæ, *Cosmarium*, 4; *Pediastrum*, 24; *Protococcus*, 64; *Scenedesmus*, 48; *Staurastrum*, 12. Infusoria, *Peridinium*, 4. Vermes, *Rotifer*, 4. Crustacea, *Daphnia*, .04. Miscellaneous, *Zoöglœa*, 40. Total, 1,756.

No. 17375. Diatomaceæ, *Synedra*, 16. Cyanophyceæ, *Anabæna*, 900; *Clathrocystis*, 450. Algæ, *Pediastrum*, 36; *Protococcus*, 8; *Scenedesmus*, 12. Infusoria, *Ceratium*, 4; *Peridinium*, 4. Total, 1,430.

Chemical Examination of Water from Tubular Wells at East Lexington.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity	Sediment	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15965	Jan. 31	None.	Slight, rusty.	.12	9.40	.0072	[illegible]	.52	.0050	.0000	.19	5.1	.0250
16376	Apr. 5	Distinct.	Slight.	.20	8.70	.0082	.0096	.50	0080	.0000	.14	4.7	.0550
16744	June 8	Slight, milky.	Slight.	.22	9.30	.0104	.0106	.51	.0030	.0000	.20	5.1	.0470
17144	Aug. 5	Distinct, milky.	Slight.	.20	10.40	.0084	.0080	.48	.0000	.0001	.22	5.5	[illegible]
17589	Oct. 6	Distinct.	Slight, rusty.	.40	11.20	.0066	.0128	.56	.0100	.0003	.31	5.9	.1600
18017	Dec. 8	Distinct.	Slight.	.30	10.30	.0112	.0116	.65	[illegible]	.0002	.21	5.2	.0900
Av.	1896	....	....	.24	9.88	.0090	.0102	.54	.0062	.0001	.21	5.3	.0742
Av.	1895	....	....	.17	9.90	.0097	.0075	.52	.0045	.0001	.18	5.5	.0958

Note to analyses of 1896: Odor, none, except in the August sample, which had a faintly vegetable odor, becoming stronger on heating. A vegetable odor was also developed on heating the samples collected in June and December. —— The samples were collected from a faucet at the pumping station.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 538, consisting chiefly of *Crenothrix*.

ASHBURNHAM.

Chemical Examination of Water from Upper Naukeag Pond, Ashburnham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15903	Jan. 20	Slight.	Slight.	.13	1.90	0.80	.0006	.0130	.0118	.0012	.10	.0050	.0000	.30	0.0
16445	Apr. 21	Slight.	Slight.	.20	1.10	0.40	.0008	.0212	.0102	.0110	.08	.0060	.0000	.40	0.0
16963	July 13	Distinct.	Slight.	.12	1.60	0.55	.0006	.0106	.0080	.0026	.12	.0000	.0000	.26	0.0
17636	Oct. 13	Slight.	Slight.	.06	1.65	0.75	.0000	.0116	.0096	.0022	.13	.0000	.0000	.25	0.0

Averages by Years.

-	1888	-	-	.13	2.01	0.60	.0002	.0145	-	-	.09	.0045	.0001	-	-
-	1889*	-	-	.05	1.95	0.85	.0000	.0196	.0134	.0062	.08	[illegible]	.0000	-	-
-	1890†	-	-	.03	2.43	1.50	.0003	.0151	.0115	.0036	.08	.0050	.0000	-	0.3
-	1891‡	-	-	[illegible]	1.90	0.85	.0000	.0122	.0122	.0000	.09	.0030	.0000	-	0.0
-	1892	-	-	.05	2.00	0.75	.0000	.0106	.0084	.0022	.11	.0050	.0000	-	0.3
-	1893	-	-	.08	1.67	0.75	.0010	.0094	.0077	.0017	.12	.0010	.0000	.14	0.2
-	1894§	-	-	.10	1.70	0.70	.0002	.0097	.0080	.0017	.13	.0065	.0001	.26	0.1
-	1895	-	-	.08	1.72	0.84	.0011	.0111	.0097	.0014	.13	.0035	.0000	.22	0.3
-	1896	-	-	.13	1.56	0.62	.0005	.0141	.0099	.0042	.11	.0025	.0000	.28	0.0

* April. † August. ‡ September. § April and August.

NOTE to analyses of 1896: Odor of the first two samples, very faint or none; of the third, decidedly mouldy and grassy; of the fourth, faintly vegetable, becoming also mouldy and grassy on heating. — The samples were collected from the pond, about 4 feet beneath the surface.

Microscopical Examination.

The total number of organisms per cubic centimeter found in each sample was as follows: No. 15903, 10; No. 16445, 45; No. 16963, 347, consisting chiefly of *Tabellaria;* No. 17636, 90.

ASHLAND.

The advice of the State Board of Health to the town of Ashland relative to taking water from the ground in the valley of the Sudbury River west of the town for the purposes of a public water supply may be found on pages 10 and 11 of this volume.

ASHLAND.

Chemical Examination of Water from a Tubular Test Well in the Valley of the Sudbury River in Ashland.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
17066	July 27	None.	Slight, sandy.	.02	7.00	.0004	.0006	.27	.0070	.0000	.01	2.5	.0110

Odor, none. —— The sample was collected from a tubular test well, on the southerly side of the Sudbury River, about 1 mile above the village of Ashland.

Microscopical Examination.

No organisms.

Water Supply of Athol. — Athol Water Company.

Chemical Examination of Water from the Large Reservoir in Phillipston.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	[illegible]														
16385	Mar. 26	Distinct.	Slight.	0.52	5.00	1.35	.0004	.0172	[illegible]	.0042	.08	.0050	.0001	0.63	0.4
16618	May 18	Decided.	Cons., brown.	0.25	2.70	0.95	.0012	.0200	.0142	.0058	.18	.0060	.0000	0.46	0.6
17052	July 24	Decided.	Cons.	0.35	4.30	1.50	.0026	.0410	.0182	.0228	.10	.0070	.0000	[illegible]	1.3
17422	Sept. 9	Decided, green.	Slight.	1.70	–	–	.0016	.1082	.0504	.0528	.74	.0120	.0000	2.47	0.8
17907	Nov. 18	Decided, green.	Cons.	0.90	4.65	2.50	.0012	.0424	.0298	.0126	.22	.0070	.0000	1.05	0.7

Averages by Years.

-	1887*	–	–	1.25	4.23	1.60	.0027	.0360	–	–	.16	.0075	–	–	–
-	1888†	–	–	0.80	3.22	1.17	.0010	.0157	–	–	11	.0127	.0000	–	–
-	1894	–	–	0.45	3.75	1.30	.0019	.0179	.0112	.0067	11	.0048	.0000	0.47	0.9
-	1895	–	–	0.64	4.00	1.44	.0016	.0364	.0174	.0190	.16	.0110	.0000	0.61	1.0
-	1896	–	–	0.74	3.66	1.57	.0014	.0447	.0251	.0196	.14	.0078	.0000	0.99	0.7

* June and December. † January to March.

Note to analyses of 1896: Odor, generally faintly vegetable and sweetish; in May, also mouldy. A fishy odor was observed in the sample collected in March. —— The samples were collected from the reservoir.

ATHOL.

Microscopical Examination of Water from the Large Reservoir in Phillipston.

[Number of organisms per cubic centimeter.]

	1896.				
	March.	May.	July.	September.	November.
Day of examination,	28	21	25	11	20
Number of sample,	16335	16618	17052	17422	17907
PLANTS.					
Diatomaceæ,	1,000	1,474	432	0	2,552
Asterionella,	1,000	424	4	0	320
Fragilaria,	0	4	4	0	0
Melosira,	0	1,008	424	0	1,200
Meridion,	0	0	0	0	8
Navicula,	0	6	0	0	8
Pinnularia,	0	4	0	0	8
Synedra,	0	6	0	0	1,008
Tabellaria,	0	22	0	0	0
Cyanophyceæ, Anabæna,	0	616	12,000	21,300	2,880
Algæ,	8	4	4	0	24
Conferva,	2	0	4	0	0
Pediastrum,	0	4	0	0	0
Protococcus,	6	0	0	0	8
Scenedesmus,	0	0	0	0	16
ANIMALS.					
Infusoria,	57	16	0	0	8
Dinobryon,	0	12	0	0	0
Euglena,	2	0	0	0	0
Monas,	0	2	0	0	0
Peridinium,	44	0	0	0	8
Phacus,	1	0	0	0	0
Synura,	10	0	0	0	0
Trachelomonas,	0	2	0	0	0
Vermes,	2	0	0	0	8
Anuræa,	0	0	0	0	8
Asplanchna,	1	0	0	0	0
Triarthra,	1	0	0	0	0
Miscellaneous, Zoöglœa,	0	40	20	0	160
TOTAL,	1,067	2,150	12,456	21,300	5,632

ATHOL.

Chemical Examination of Water from Newton (Buckman Brook) Reservoir and its Tributaries in Athol.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Diss[redacted]	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
15910	Jan. 20	Slight.	Slight.	.37	3.10	1.20	.0004	.0098	.0084	.0014	12	.0070	.0000	.50	0.5
15911	Jan. 20	V. slight.	Cons., brown.	.37	2.75	1.10	.0004	.0096	.0062	.0034	.09	.0050	.0000	.48	0.6
15912	Jan. 20	None.	Slight.	.10	2.80	0.80	.0008	.0032	.0026	.0006	.12	.0060	.0000	.22	0.3
15913	Jan. 20	V. slight.	Cons., brown.	.05	2.45	0.80	[redacted]	.0020	.0016	.0004	15	.0100	.0000	.09	0.4

Odor, none. —— The first sample was collected from the reservoir; the second, from a brook entering the reservoir from the west; the third, from a brook entering the reservoir from the south-west; the last, from a brook entering the reservoir from the south-east.

Microscopical Examination.

An insignificant number of organisms was found in the first sample; in the other samples no organisms were found.

Water Supply of Attleborough.

Chemical Examination of Water from the Well of the Attleborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1896.												
15899	Jan. 17	None.	None.	.00	3.80	.0002	.0006	.36	.0120	.0000	.04	3.5	.0010
16050	Feb. 11	None.	None.	.02	3.60	.0004	.0012	.34	.0170	.0000	.10	2.0	.0060
16354	Mar. 31	None.	None.	.00	2.60	[redacted]	.0014	.36	.0150	.0000	.05	1.8	.0020
16423	Apr. 15	None.	None.	.00	3.40	.0010	.0012	.34	.0150	.0000	.03	2.0	.0000
16564	May 11	None.	None.	.00	3.40	[redacted]	.0034	.37	.0120	[redacted]	.00	1.7	.0020
16750	June 10	None.	None.	.00	4.40	.0000	.0026	.32	.0150	[redacted]	.06	1.6	[redacted]
16999	July 15	None.	None.	.00	4.10	.0000	.0012	.32	.0100	[redacted]	.06	1.7	.0020
17230	Aug. 18	V. slight, milky.	Slight.	.03	3.50	.0000	.0042	.30	.0070	[redacted]	.06	1.9	.0010
17482	Sept. 11	None.	None.	.02	3.70	.0000	.0024	.34	.0070	[redacted]	.04	1.7	.0040
17829	Oct. 12	None.	None.	.03	4.30	.0008	.0042	.38	.0120	.0000	.09	1.8	.0050
17864	Nov. 13	None.	V. slight.	.03	5.10	.0000	.0014	.45	.0120	.0000	.05	2.2	.0010
18115	Dec. 14	None.	None.	.01	4.40	.0014	.0032	.42	.0120	.0000	.06	2.2	.0000

ATTLEBOROUGH.

Chemical Examination of Water from the Well of the Attleborough Water Works — Concluded.

Averages by Years.

[Parts per 100,000.]

Number	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1893	-	-	.02	4.43	.0000	.0006	.36	.0210	.0000	.08	2.0	.0065
-	1894	-	-	.02	3.96	.0002	.0014	.37	.0193	.0000	.04	1.8	.0043
-	1895	-	-	.03	4.02	.0001	.0027	.36	.0129	[illegible]	.04	1.8	.0019
-	1896	-	-	.01	3.83	.0003	.0022	.36	.0122	.0000	.05	1.9	.0025

NOTE to analyses of 1896: Odor, none. —— The samples were collected from a faucet at the pumping station, while pumping.

Microscopical Examination.

No organisms.

Chemical Examination of Water from Orr's Spring, Attleborough.

[Parts per 100,000.]

Number	Date of Collection	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
16845	1896. June 20	None.	Slight.	.00	2.90	.0000	.0004	.34	.0080	.0000	.01	0.6	.0000

Odor, none. —— The sample was collected from a spring on land of James Orr, about 1,500 feet below Orr's Pond.

Microscopical Examination.

No organisms.

WATER SUPPLY OF AVON.

Chemical Examination of Water from the Well of the Avon Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed	Hardness	Iron.
16760	1896. June 8	Slight.	Slight.	.00	4.30	.0000	.0034	.45	.0300	.0000	.03	1.3	.0300

Odor, none. —— The sample was collected from a faucet at the pumping station, while pumping.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

AYER.

WATER SUPPLY OF AYER.

Chemical Examination of Water from the Well of the Ayer Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16755	June 9	V. slight.	Cons., white.	.00	6.20	.0000	.0016	.53	.0600	.0000	.09	2.7	.0030

Averages by Years.

-	1888	-	-	.00	5.35	.0002	.0015	.32	.0626	.0001	-	-	-
-	1889*	-	-	.00	4.90	.0010	.0022	.31	.0666	.0000	-	-	-
-	1890†	-	-	.00	5.60	.0000	.0014	.32	.0900	.0000	-	-	-
-	1893‡	-	-	.00	5.30	.0000	.0008	.36	.0500	.0000	.05	2.1	.0000
-	1894§	-	-	.01	4.58	.0000	.0005	.40	.0703	.0000	.01	2.4	.0163
-	1895‖	-	-	.01	6.20	.0009	.0011	.50	.0667	.0000	.01	2.6	.0018
-	1896	-	-	.00	6.20	.0000	.0016	.53	.0600	.0000	.09	2.7	.0030

* January to May. † September. ‡ June. § April, July, August. ‖ June, August, October.

NOTE to analysis of 1896: Odor, none. — The sample was collected from the well.

Microscopical Examination.

No organisms.

WATER SUPPLY OF BARRE. — BARRE WATER COMPANY.

Chemical Examination of Water from the Reservoir of the Barre Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1896.														
16040	Feb. 11	Distinct, clayey.	Slight, clayey.	.29	3.40	1.00	.0030	.0122	.0106	.0016	.18	.0150	.0002	.25	1.0
16357	Apr. 6	Distinct, clayey.	Slight, earthy.	.12	3.00	0.70	.0044	.0148	.0134	.0014	.10	.0070	.0000	.19	0.5
16709	June 1	Distinct, clayey.	Slight, fibrous.	.02	5.20	1.10	.0016	.0174	.0128	.0046	.25	.0000	.0000	.18	2.3
17154	Aug. 8	None.	V. slight.	.03	7.40	1.75	.0000	.0106	.0092	.0014	.28	.0000	.0001	.21	3.0
17628	Oct. 11	Distinct.	Cons.	.22	5.15	1.55	.0024	.0248	.0182	.0066	.16	.0070	.0000	.40	1.8
18013	Dec. 7	V. slight.	V. slight.	.20	3.90	1.00	.0002	.0108	.0084	.0024	.19	.0050	.0000	.27	1.8
Av...	....	....	....	.15	4.67	1.18	.0019	.0151	.0121	.0030	.19	.0057	.0001	.25	1.7

Odor, faintly vegetable and frequently also mouldy, becoming somewhat stronger on heating. — No. 18013 was collected from a faucet at the dead end of a pipe line; the other samples were collected from the reservoir.

BARRE.

Microscopical Examination of Water from the Reservoir of the Barre Water Company.

[Number of organisms per cubic centimeter.]

	1896.					
	Feb.	Apr.	June.	Aug.	Oct.	Dec.
Day of examination,	12	7	3	11	13	9
Number of sample,	16040	16357	16709	17154	17628	18018
PLANTS.						
Diatomaceæ,	0	0	440	2	0	0
Synedra,	0	0	436	0	0	0
Tabellaria,	0	0	4	2	0	0
Algæ, Scenedesmus,	0	7	0	0	0	0
ANIMALS.						
Rhizopoda, Difflugia,	0	0	0	1	0	0
Infusoria,	28	44	0	32	1	0
Ciliated infusorian,	0	1	0	0	0	0
Dinobryon,	28	41	0	12	0	0
Monas,	0	0	0	3	1	0
Peridinium,	0	2	0	15	0	0
Trachelomonas,	0	0	0	2	0	0
Vermes, Asplanchna,	0	0	0	1	0	0
Crustacea.	0	0	.02	0	.34	0
Bosmina,	0	0	.02	0	0	0
Daphnia,	0	0	0	0	.34	0
Miscellaneous, Zoöglœa,	0	0	80	0	20	0
Total,	28	51	520	36	21	0

WATER SUPPLY OF BELMONT.

(See *Watertown.*)

WATER SUPPLY OF BEVERLY.

(See *Salem.*)

BILLERICA.

BILLERICA.

Chemical Examination of Water from Tubular Test Wells in Billerica.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
17327	Aug. 29	Slight.	Slight, sandy.	.02	[illegible]	.0008	.0004	.20	.0070	[illegible]	.02	1.9	.0030
17370	Sept. 5	Distinct, clayey.	Slight, earthy.	.07	6.70	.0000	[illegible]	[illegible]	.0030	[illegible]	.02	2.8	.0820

Odor, none. —— The first sample was collected from a test well on the west bank of the Concord River, about 1,500 feet north of "Corner Bridge," between the villages of Billerica and North Billerica. The last sample was collected from a test well in the valley of Content Brook in East Billerica, about 400 feet west of the road from East Billerica to Billerica Centre. These samples were collected during an investigation relative to obtaining a water supply for the town of Billerica.

Microscopical Examination.

No organisms.

WATER SUPPLY OF BOSTON.

In 1896 the town of Natick, the densely populated portion of which is situated within the watershed of Lake Cochituate, completed a system of sewage disposal, and a few connections with the sewers were made in the latter part of the year. The sewage-disposal area is close to that used by the town of Framingham for a similar purpose, and outside of the limits of the Sudbury and Cochituate watersheds.

Works have also been completed for the filtration of drainage flowing from the underdrain of the Framingham sewer system, which was formerly discharged into one of the tributaries of Lake Cochituate. A filtration area for the disposal of this water has been prepared not far from the sewage pumping station and within the Cochituate watershed. The drainage may also be diverted into the sewage-receiving reservoir at the pumping station and disposed of in connection with the sewage, and a portion of the drainage has been disposed of in this way.

Work incidental to the construction of Dam No. 5 and the preparation of the large area of ground to be flowed by this reservoir has unfavorably affected the quality of the water of Stony Brook and Reservoir No. 3, as in the two previous years, and the use of water from Reservoir No. 3 has been avoided as far as possible.

BOSTON.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Indian Brook, at Head of Reservoir No. 6, Hopkinton.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
15825	Jan. 1	Slight.	Slight.	1.15	4.85	2.35	.0000	.0216	.0204	.0012	0.52	.0030	.0000	1.14	0.9
15955	Feb. 3	None.	V. slight.	1.20	5.45	2.50	.0006	.0214	.0180	.0034	0.46	.0000	.0000	1.09	1.0
16170	Mar. 2	Distinct, clayey	Slight, earthy.	0.38	3.25	1.10	.0132	.0226	.0186	.0040	0.21	.0200	.0005	0.49	0.5
16339	Apr. 1	V. slight.	V. slight.	0.60	2.95	1.35	.0000	.0134	.0116	.0018	0.22	.0050	.0000	0.50	0.6
16523	May 4	V. slight.	Slight.	1.80	4.80	2.75	.0012	.0366	.0350	.0016	0.30	.0020	.0001	1.47	0.6
16695	June 1	Slight.	Slight.	2.50	5.55	4.00	[illegible]	.0536	.0506	.0030	0.30	.0000	.0000	2.09	1.3
16889	July 1	V. slight.	Slight.	1.20	7.40	3.75	.0060	.0398	.0362	.0036	0.30	.0030	.0002	–	1.7
17109	Aug. 3	Slight.	Slight.	0.92	6.75	2.70	.0010	.0284	.0250	.0034	0.72	[illegible]	.0001	1.27	1.7
17333	Sept. 1	Decided.	Slight.	1.50	6.40	3.25	.0004	.0474	.0434	.0040	0.48	.0000	[illegible]	1.99	1.5
17565	Oct. 1	Slight.	V. slight.	1.50	9.55	5.00	.0006	.0486	.0476	.0010	1.06	.0030	.0001	2.57	2.4
17750	Nov. 2	V. slight.	V. slight.	2.00	7.25	4.60	.0004	.0378	.0352	.0026	0.66	.0030	.0000	2.35	1.9
17973	Dec. 1	None.	V. slight.	1.40	6.20	3.20	.0004	.0334	.0294	[illegible]	0.73	.0030	.0000	1.76	1.2

Averages by Years.

-	1894	-	-	2.16	6.56	3.36	.0014	.0323	[illegible]	.0024	.54	.0018	.0000	1.76	1.6
-	[illegible]	-	-	1.72	6.17	[illegible]	.0006	.0358	.0327	.0031	.56	.0029	.0000	1.84	1.6
-	1896	-	-	1.37	5.95	2.95	.0020	.0337	.0309	.0028	.60	.0039	.0001	1.52	1.3

NOTE to analyses of 1896: Odor, distinctly vegetable and frequently also mouldy, becoming somewhat stronger on heating. — The samples were collected from the brook, at its entrance to Reservoir No. 6.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 56.

BOSTON.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Reservoir No. 6, Ashland, collected near the Surface.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
15826	Jan. 1	Slight.	Slight.	1.08	4.35	2.30	.0050	.0250	.0238	.0012	.33	.0050	[redacted]	1.25	0.9
15989	Feb. 3	V. slight.	Slight.	1.00	4.40	2.25	.0040	.0228	.0204	.0024	.28	.0050	.0000	0.94	0.9
16171	Mar. 2	Distinct, clayey.	Slight.	0.75	3.65	1.55	.0048	.0206	.0180	.0026	.19	.0030	.0000	0.67	0.6
16340	Apr. 1	Distinct.	Slight.	0.70	3.70	1.70	.0010	.0164	.0130	.0034	.24	.0070	.0001	0.62	0.6
16524	May 4	Distinct.	Slight.	0.60	3.38	1.40	.0014	.0174	.0144	.0030	.24	.0050	.0001	0.60	0.5
16696	June 1	Distinct.	Slight.	0.55	3.35	1.55	.0000	.0154	.0134	.0020	.31	.0050	.0000	0.57	0.5
16900	July 1	Slight.	Slight.	0.60	3.65	1.75	[redacted]	.0172	.0156	.0014	.30	.0050	.0001	–	0.6
17110	Aug. 3	Distinct, brown.	Slight.	0.45	3.45	1.58	.0008	.0188	.0142	.0046	.34	.0050	.0001	0.51	0.7
17334	Sept. 1	Distinct.	Slight.	0.38	3.30	1.60	.0008	.0228	.0164	.0064	[redacted]	.0000	.0001	0.50	0.6
17566	Oct. 1	Distinct.	Cons.	[redacted]	3.50	1.20	.0006	.0240	.0192	.0048	.34	.0030	[redacted]	[redacted]	1.0
17760	Nov. 2	Distinct.	Slight.	0.40	3.35	1.85	.0000	.0238	.0180	.0058	.44	.0020	[redacted]	0.67	1.1
17974	Dec. 1	Distinct, brown.	Slight.	[redacted]	5.25	2.20	.0006	.0260	.0236	.0022	.52	[redacted]	.0000	0.92	1.6

Averages by Years.

–	1894	–	–	0.79	[redacted]	1.60	[redacted]	.0191	.0166	.0025	.40	.0040	.0001	0.75	1.2
–	1895	–	–	0.73	4.15	[redacted]	.0017	.0239	.0210	.0029	.40	.0048	.0000	0.76	1.3
–	1896	–	–	0.61	3.86	1.74	.0017	.0208	.0175	.0033	.32	.0040	.0001	0.71	0.9

NOTE to analyses of 1896 Odor, vegetable and occasionally mouldy, becoming somewhat stronger on heating. The iron was determined in eleven samples, the average amount found being .0155 parts per 100,000. —— The samples were collected from the reservoir, near the dam. For monthly record of height of water in this reservoir, see table at end of Boston analyses.

BOSTON.

SUDBURY RIVER SUPPLY.—*Microscopical Examination of Water from Reservoir No. 6, Ashland, collected near the Surface.*

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	2	4	3	3	[illegible]	2	2	4	2	2	3	2
Number of sample,	15826	15969	16171	16340	16524	[illegible]	16900	17110	17284	17566	17760	17974
PLANTS.												
Diatomaceæ,	8	3	1	7	63	76	15	504	348	378	254	7
Cyclotella,	0	0	0	0	0	0	3	0	0	8	56	3
Diatoma,	0	0	0	0	0	0	0	0	0	20	[illegible]	0
Melosira,	8	2	0	0	0	0	0	0	0	0	0	0
Meridion,	0	0	0	4	5	0	0	0	0	0	0	0
Stephanodiscus,	0	0	0	0	0	0	0	0	0	0	6	0
Synedra,	0	1	1	3	44	0	0	0	0	2	8	1
Tabellaria,	0	0	0	0	14	76	12	504	348	348	184	3
Cyanophyceæ,	0	0	0	0	0	4	0	0	44	4	0	0
Anabæna,	0	0	0	0	0	4	0	0	42	0	0	0
Clathrocystis,	0	0	0	0	0	[illegible]	0	0	2	4	[illegible]	0
Algæ,	2	3	0	0	2	11	390	68	90	28	22	3
Arthrodesmus,	0	0	0	0	0	6	0	0	2	0	10	1
Cœlastrum,	0	0	0	0	0	0	84	0	0	0	0	0
Protococcus,	0	0	0	0	0	0	296	68	88	20	0	2
Raphidium,	2	3	0	0	2	5	10	0	0	8	12	0
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	0	0	0	2	[illegible]	[illegible]	0	0	0
Infusoria,	1	1	6	0	3	12	2	[illegible]	8	18	80	26
Codonella,	0	0	0	0	0	0	0	[illegible]	0	2	0	0
Dinobryon,	0	0	5	0	0	12	0	0	0	14	60	0
Mallomonas,	0	0	0	0	0	0	1	1	6	0	0	0
Peridinium,	1	1	1	0	3	0	1	26	2	2	20	26
Vermes, Anuræa,	0	0	0	0	0	0	2	0	0	0	0	0
Crustacea, Cyclops,	0	0	0	0	.06	0	[illegible]	0	0	0	0	0
Miscellaneous,	0	0	5	0	20	10	4	5	[illegible]	40	70	50
Acarina,	0	0	0	0	.06	0	.02	0	0	0	0	0
Zoöglœa,	0	0	5	0	20	10	4	5	50	40	70	50
TOTAL,	11	7	12	7	93	115	415	606	540	468	426	86

BOSTON.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Reservoir No. 6, Ashland, collected near the Bottom.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15827	Jan. 1	Slight.	Slight.	1.06	4.35	2.05	.0034	.0234	.0222	.0012	[illegible]	.0050	.0000	[illegible]	0.9
15990	Feb. 3	Slight.	Slight.	1.00	4.30	2.55	.0022	.0220	.0208	.[illegible]	.32	.0050	.0000	1.09	0.9
16341	Apr. 1	Slight.	Slight.	0.70	3.65	1.50	.0030	.0214	.0170	.0044	.28	.0070	.0001	0.61	0.8
16525	May 4	Distinct.	Slight.	0.60	3.30	1.55	.0024	.0168	.0144	.0014	.24	.0070	.0001	0.54	0.7
16697	June 1	Slight.	Slight.	0.55	3.35	1.45	.0010	.0120	.0102	.0018	.30	.0030	.0000	0.56	0.6
16901	July 1	Slight.	Slight.	0.50	3.55	1.75	.0022	.0154	.0126	.0028	.30	.0070	.0001	–	0.7
17111	Aug. 3	Slight.	Slight.	0.47	3.50	1.60	.0012	.0110	.0100	.0010	.35	.0050	.0002	0.70	0.5
17335	Sept. 1	Distinct.	Slight.	0.40	3.90	1.00	.0008	.0202	.0180	.0022	.34	.0000	.0001	0.56	0.5
17567	Oct. 1	Distinct.	Cons.	0.30	3.25	1.10	.0000	.0214	.0174	.0040	.35	.0030	.0001	0.50	1.4
17761	Nov. 2	Slight.	Slight.	0.40	3.35	1.90	.0000	.0212	.0170	.0042	.44	.0060	.0000	0.61	1.1
17975	Dec. 1	Slight, brown.	Slight.	0.90	5.05	2.25	.0004	.0238	.0210	.0028	.56	.0080	.0001	0.92	1.7

Averages by Years.

–	1894*	–	–	1.01	4.06	1.73	.0062	.0175	.0149	.0026	.38	.0026	.0004	0.67	1.2
–	1895	–	–	0.75	4.33	1.94	.0036	.0204	.0181	.0023	.41	.0064	.0001	0.77	1.8
–	1896	–	–	0.63	3.63	1.75	.0015	.0189	.0164	.0025	.35	.0060	.0001	0.71	0.9

* April to December.

NOTE to analyses of 1896: Odor, faintly vegetable, becoming stronger on heating. The iron was determined in all the samples, the average amount in parts per 100,000 being .0171. —— The samples were collected from the reservoir, near the dam. For monthly record of height of water in this reservoir, see table at end of Boston analyses.

BOSTON.

SUDBURY RIVER SUPPLY. — *Microscopical Examination of Water from Reservoir No. 6, Ashland, collected near the Bottom.*

[Number of organisms per cubic centimeter.]

	[illegible]										
	Jan.	Feb.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	3	4	8	[illegible]	2	2	4	2	2	3	2
Number of sample,	15827	15990	16341	16525	16697	16901	17111	17835	17567	17761	17975
PLANTS.											
Diatomaceæ,	2	1	39	13	1	49	8	227	292	208	20
Cyclotella,	0	0	1	0	0	1	3	0	0	10	14
Navicula,	2	0	0	2	0	0	0	2	0	0	0
Stephanodiscus,	0	0	0	0	0	0	0	0	0	6	0
Synedra,	0	1	36	6	1	0	1	0	0	20	4
Tabellaria,	0	0	2	5	0	48	4	225	292	172	2
Cyanophyceæ, Anabæna,	0	0	0	0	0	0	0	22	0	0	0
Algæ,	2	3	1	1	0	48	1	70	14	16	4
Arthrodesmus,	2	1	0	0	0	2	0	2	0	4	0
Protococcus,	0	0	1	0	0	46	1	68	8	2	0
Raphidium,	0	2	0	1	0	0	0	0	6	10	4
ANIMALS.											
Infusoria,	2	0	0	0	2	1	2	10	14	37	38
Codonella,	0	0	0	0	0	0	0	0	2	0	0
Dinobryon,	0	0	0	0	1	0	2	0	10	32	0
Mallomonas,	0	0	0	0	0	1	0	8	0	0	0
Peridinium,	2	0	0	0	0	0	0	2	2	5	38
Vorticella,	0	0	0	0	1	0	0	0	0	0	0
Vermes,	0	0	0	0	0	7	0	1	0	0	0
Anurea,	0	0	0	0	0	7	0	0	0	0	0
Rotifer,	0	0	0	0	0	0	0	1	0	0	0
Crustacea, Entomostracan ova,	0	0	0	0	0	1	0	[illegible]	0	0	0
Miscellaneous, Zoöglœa,	0	10	[illegible]	0	0	0	[illegible]	40	40	40	60
TOTAL,	6	14	50	14	3	112	21	370	360	301	122

BOSTON.

Sudbury River Supply. — *Chemical Examination of Water from Cold Spring Brook, at Head of Reservoir No. 4, Ashland.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15828	Jan. 1	Slight.	Slight.	1.30	4.45	2.35	.0004	.0254	.0244	.0010	.24	.0000	.0000	1.56	0.9
15991	Feb. 3	Slight.	Slight.	1.00	4.20	1.90	.0006	.0186	.0164	.0022	.24	.0070	.0000	0.87	0.8
16179	Mar. 2	Distinct, clayey.	Slight.	0.75	3.15	1.40	.0000	.0204	.0196	.0008	.10	.0050	.0000	0.66	0.3
16342	Apr. 1	V. slight.	V. slight.	0.70	3.00	1.05	.0000	.0160	.0138	.0022	.16	.0030	.0001	0.64	0.5
16526	May 4	Slight.	Slight.	1.70	4.75	2.55	.0016	.0342	.0304	.0038	.24	.0050	.0000	1.22	1.3
16698	June 1	V. slight.	Slight.	1.40	4.45	2.40	.0006	.0270	.0232	.0038	.21	.0000	.0000	1.14	0.8
16902	July 1	Slight.	Slight.	1.30	4.20	2.35	.0016	.0348	.0320	.0028	.19	.0090	.0000	-	1.1
17112	Aug. 3	V. slight.	Slight.	0.90	4.40	1.85	.0004	.0248	.0222	.0026	.28	.0030	.0000	0.91	1.1
17336	Sept. 1	V. slight.	V. slight.	0.63	4.20	1.65	.0020	.0176	.0154	.0022	.31	.0080	.0001	0.46	1.1
17571	Oct. 1	Slight.	Cons.	1.20	6.15	3.15	.0044	.0442	.0414	.0028	.34	.0050	.0001	1.67	1.5
17763	Nov. 2	None.	V. slight.	1.80	7.05	4.05	.0004	.0386	.0352	.0034	.35	.0050	.0000	2.06	1.7
17976	Dec. 1	V. slight.	V. slight.	1.45	6.90	3.75	.0006	.0406	.0380	.0026	.43	.0030	.0000	2.26	1.4

Averages by Years.

-	1889*	-	-	2.24	-	-	.0025	.0410	.0385	.0025	.28	.0056	.0001	-	-
-	1890	-	-	0.91	4.48	2.01	.0011	.0248	.0210	.0038	.24	.0090	.0001	-	1.5
-	1891	-	-	1.30	4.57	2.30	.0009	.0297	.0262	.0035	.23	.0087	.0001	-	1.3
-	1892	-	-	1.44	5.16	2.57	.0008	.0308	.0266	.0042	.25	.0066	.0001	-	1.2
-	1893	-	-	1.23	4.52	2.16	.0013	.0248	.0212	.0036	.26	.0031	.0001	0.96	1.3
-	1894	-	-	1.44	4.94	2.42	.0007	.0237	.0214	.0023	.31	.0045	.0000	1.20	1.2
-	1895	-	-	1.19	4.70	2.46	.0006	.0285	.0261	.0024	.32	.0034	.0000	1.16	1.2
-	1896	-	-	1.17	4.74	2.37	.0011	.0285	.0260	.0025	.26	.0034	.0000	1.21	1.0

* June to December.

Note to analyses of 1896: Odor, generally distinctly vegetable and mouldy, becoming stronger on heating. —— The samples were collected from the brook, at its entrance into Reservoir No. 4.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 57.

BOSTON.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Reservoir No. 4, Ashland.*

[Parts per 100,000

Number.	Date of Collection.	Appearance. Turbidity.	Sediment.	Color.	Residue on Evaporation. Total.	Loss on Ignition.	Ammonia. Free.	Albuminoid. Total.	Dissolved.	Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
15829	Jan. 1	Slight.	Slight.	1.05	4.40	[illegible]	.0010	.0292	.0276	.0016	.27	.0090	.0000	1.23	1.1
15991	Feb. 3	Slight.	Slight.	1.06	4.25	2.20	.0018	.0266	.0248	.0018	.24	.0050	.0000	1.56	1.0
16172	Mar. 2	Slight, clayey.	Slight.	0.96	3.65	1.50	.0016	.0240	.0226	.0014	.17	.0050	[illegible]	0.86	0.8
16527	May 4	Slight.	Slight.	0.80	3.50	1.60	.0024	.0238	.0204	.0034	.26	.0070	.0001	0.70	0.8
16528	May 4	Slight.	Slight.	0.80	3.40	1.45	.0020	.0188	.0178	.0010	.25	.0050	.0000	0.70	0.8
16690	June 1	Distinct.	Slight.	0.85	3.30	1.75	.0000	.0202	.0160	.0042	.25	.0000	.0000	0.76	0.6
16903	July 1	Distinct.	Slight.	0.75	3.75	2.05	.0008	.0210	.0170	.0040	.24	.0000	.0000	-	0.9
16904	July 1	Distinct.	Slight.	0.70	3.65	2.00	.0004	.0202	.0174	.0028	.22	.0020	.0000	-	0.6
17113	Aug 3	Distinct.	Slight.	0.50	3.45	1.45	.0002	.0190	.0176	.0014	.26	.0030	.0000	0.62	0.6
17337	Sept. 1	Slight.	Slight.	0.35	3.45	1.55	.0002	.0230	.0192	.0038	.30	.0030	.0001	0.56	1.1
17572	Oct. 1	Distinct.	Slight.	0.57	3.75	1.55	.0008	.0254	.0198	.0056	.26	.0000	.0000	0.61	0.8
17764	Nov. 2	Distinct.	Cons.	0.75	4.50	2.30	.0000	.0248	.0230	.0018	.28	.0000	.0000	0.96	1.2
17977	Dec. 1	Slight.	Slight.	0.67	5.00	2.35	.0006	.0290	.0246	.0044	.40	.0006	.0000	1.42	1.3

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1887*	-	-	0.74	3.71	1.51	.0005	.0246	-	-	.25	.0033	-	-	-
-	1888	-	-	0.72	3.68	1.70	.0007	.0277	-	-	.22	.0054	.0001	-	-
-	1889	-	-	0.65	3.48	1.50	.0016	.0251	.0218	.0033	.23	.0068	.0002	-	-
-	1890	-	-	0.61	3.67	1.40	.0006	.0222	.0191	.0031	.24	.0096	.0001	-	1.7
-	1891	-	-	0.55	3.24	1.66	.0006	.0187	.0166	.0031	.20	.0062	.0001	-	0.9
-	1892	-	-	0.64	3.60	1.52	[illegible]	.0200	.0165	.0032	.23	.0061	.0001	-	1.1
-	1893	-	-	0.77	3.54	1.68	.0024	.0206	.0178	.0033	.23	.0048	.0001	0.68	1.0
-	1894	-	-	0.63	4.00	1.78	.0027	.0202	.0180	.0022	.29	.0045	.0001	0.78	1.1
-	1895	-	-	0.59	4.22	2.04	.0015	[illegible]	.0223	.0023	.32	.0052	.0000	0.90	1.1
-	1896†	-	-	0.75	3.90	1.86	.0008	.0239	.0210	.0029	.27	.0024	.0000	0.91	0.9

* June to December.

† Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1896: Odor, vegetable; generally stronger on heating. The iron was determined in nine samples, the average amount in parts per 100,000 being .0138 —— The samples were collected from the reservoir, near the gate-house. Nos 16172, 16528 and 16904 were collected 8 feet beneath the surface, and the others 1 foot beneath the surface. For monthly record of height of water in this reservoir, see table at end of Boston analyses.

BOSTON.

SUDBURY RIVER SUPPLY.— *Microscopical Examination of Water from Reservoir No. 4, Ashland.*

[Number of organisms per cubic centimeter.]

	1896.												
	Jan.	Feb.	Mar.	May.	May.	June.	July.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	2	4	3	5	6	2	2	2	4	2	2	3	2
Number of sample,	15829	15992	16172	16527	16528	16699	16903	16904	17113	17337	17572	17764	17977
PLANTS.													
Diatomaceæ,	83	56	37	57	32	295	88	57	11	18	14	200	434
Asterionella,	0	0	8	0	0	64	0	0	0	0	0	0	0
Cyclotella,	38	0	2	0	0	228	80	52	9	11	4	132	388
Diatoma,	0	0	0	0	0	0	0	0	0	2	4	0	0
Fragilaria,	0	0	6	0	0	0	8	0	0	0	0	0	0
Melosira,	0	0	1	0	0	0	0	0	0	0	0	0	6
Meridion,	0	0	4	1	2	0	0	0	0	0	0	0	0
Navicula,	0	0	2	0	0	0	0	0	1	1	2	2	0
Stephanodiscus,	0	20	1	26	8	0	0	0	0	0	0	2	0
Synedra,	45	36	4	28	20	1	0	0	1	4	2	64	40
Tabellaria,	0	0	7	0	2	2	0	5	0	0	2	0	0
Algæ,	2	0	1	0	1	0	0	5	10	0	0	4	0
Protococcus,	0	0	1	0	1	0	0	5	1	0	0	0	0
Raphidium,	2	0	0	0	0	0	0	0	9	0	0	4	0
ANIMALS.													
Rhizopoda, Actinophrys,	0	0	0	0	0	0	2	3	0	0	[illegible]	0	0
Infusoria,	0	0	4	2	2	0	0	2	2	0	0	0	0
Dinobryon,	0	0	4	2	1	0	0	0	0	0	0	0	0
Mallomonas,	0	0	0	0	1	0	0	2	[illegible]	0	0	0	0
Vermes,	0	1	[illegible]	3	1	0	0	0	1	0	2	0	0
Anuræa,	0	0	0	2	0	0	0	0	0	0	0	0	0
Rotatorian ova,	0	1	0	0	0	0	0	0	1	0	0	0	0
Rotifer,	0	0	0	1	1	0	0	0	0	0	2	0	0
Crustacea,	0	0	0	0	0	.08	.06	.08	0	[illegible]	0	0	[illegible]
Bosmina,	0	0	0	0	0	0	.02	0	0	0	0	0	0
Cyclops,	0	0	0	0	0	0	.04	.04	0	0	0	0	0
Daphnia,	0	0	0	0	0	.08	0	.04	0	0	0	0	0
Miscellaneous,	10	0	0	0	0	40	3	2	10	30	20	5	15
Acarina,	0	0	0	0	0	0	0	0	.02	0	0	0	0
Zoöglœa,	10	0	0	0	0	40	3	2	10	30	20	5	15
TOTAL,	95	57	42	62	36	335	93	69	34	48	36	209	449

BOSTON.

Sudbury River Supply. — ***Chemical Examination of Water from Reservoir No. 4, Ashland, collected near the Bottom.***

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.					Nitrogen as		Oxygen Consumed	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended	Chlorine.	Nitrates	Nitrites		
	1896.														
15993	Feb. 3	Slight.	Slight.	1.05	4.25	2.20	.0050	.0232	.0205	.0024	.21	.0050	.0000	1.28	1.0
16172	Mar. 2	Slight.	Slight.	1.10	4.65	2.10	.0034	.0242	.0226	.0016	.19	.0030	.0002	1.04	0.9
16344	Apr. 1	Slight.	Slight.	0.80	3.70	1.80	.0010	.0198	.0180	.0018	.22	.0070	.0001	0.75	0.9
16700	June 1	Slight, fibrous.	Slight, fibrous.	0.75	3.35	1.90	.0012	.0160	.0144	.0016	.22	.0070	.0000	0.65	0.6
17114	Aug. 3	Distinct, clayey.	Slight.	0.60	3.56	1.45	0016	.0158	.0134	.0024	.26	.0050	.0000	0.78	0.7
17338	Sept. 1	Slight.	Slight.	0.35	3.85	1.60	.0006	.0188	.0164	.0024	.23	.0080	.0000	0.53	1.1
17573	Oct. 1	Distinct.	Slight.	0.37	3.70	1.50	.0000	.0234	.0208	.0026	.28	.0030	.0000	0.59	0.8
17765	Nov. 2	Distinct.	Slight, fibrous.	0.72	4.60	2.20	.0000	.0234	.0180	.0054	.30	.0020	.0000	0.96	1.3
17978	Dec. 1	Slight.	Slight.	0.87	4.95	2.25	.0002	.0274	.0230	.0044	.36	.0000	.0000	1.44	1.3

Averages by Years.

-	1887*	-	-	0.66	3.61	1.41	.0016	.0231	-	-	.22	.0050	-	-	-
-	1888	-	-	0.72	4.02	1.70	.0025	.0261	-	-	.23	.0059	.0001	-	-
-	1889	-	-	0.86	3.55	1.49	.0023	.0224	.0196	.0026	.22	.0086	.0002	-	-
-	1890	-	-	0.66	3.97	1.64	.0017	.0199	.0168	.0031	.23	.0120	.0001	-	1.6
-	1892†	-	-	0.48	3.45	1.45	.0002	.0142	.0108	.0034	.25	.0100	.0001	-	1.3
-	1893‡	-	-	0.86	4.15	1.77	.0024	.0187	.0162	.0025	.28	.0125	.0000	0.74	1.4
-	1895§	-	-	0.80	4.07	1.57	.0020	.0197	.0183	.0014	.30	.0060	.0000	0.82	1.1
-	[illegible]	-	-	0.73	4.07	1.59	.0012	.0213	.0186	.0027	.26	.0039	.0000	0.85	1.0

* May to November. † September. ‡ February and September. § July and August.

Note to analyses of 1896: Odor, vegetable. The iron was determined in all the samples, the average amount in parts per 100,000 being .0144. —— The samples were collected from the reservoir, near the gate-house. For monthly record of height of water in this reservoir, see table at end of Boston analyses.

BOSTON.

SUDBURY RIVER SUPPLY. — *Microscopical Examination of Water from Reservoir No. 4, Ashland, collected 40 Feet beneath the Surface.*

[Number of organisms per cubic centimeter.]

	1896.								
	Feb.	Mar.	April.	June.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	4	3	3	2	4	2	2	3	2
Number of sample,	15993	16173	16344	16700	17114	17338	17573	17765	17978
PLANTS.									
Diatomaceæ,	36	15	7	46	5	[illegible]	22	540	203
Cyclotella,	0	0	2	44	0	18	12	440	132
Navicula,	0	1	0	0	0	0	4	0	1
Stephanodiscus,	24	10	0	0	1	0	0	0	0
Synedra,	12	4	5	1	2	2	2	100	64
Tabellaria,	0	0	0	1	2	0	4	0	6
Algæ,	0	0	10	0	0	1	8	22	2
Protococcus,	0	0	10	0	0	1	0	0	2
Raphidium,	0	0	0	0	0	0	8	22	0
ANIMALS.									
Infusoria,	0	0	10	0	1	1	2	0	0
Dinobryon,	0	0	8	0	0	0	0	0	0
Euglena,	0	0	1	0	0	0	0	0	0
Trachelomonas,	0	0	0	0	1	1	2	0	0
Vorticella,	0	0	1	0	0	0	0	0	0
Vermes, Monocerca,	0	0	0	0	0	0	1	0	0
Miscellaneous, Zoöglœa,	0	0	0	5	[illegible]	40	50	120	[illegible]
TOTAL,	36	15	27	[illegible]	26	62	83	682	225

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Sudbury River, at Head of Reservoir No. 2, Ashland.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15830	Jan. 1	V. slight.	V. slight.	0.93	3.80	1.55	.0012	.0194	.0174	.0020	.26	.0050	.0000	1.12	0.8
15994	Feb. 3	V. slight.	V. slight.	0.90	4.50	1.80	.0010	.0192	.0182	.0010	.22	.0100	.0000	0.93	0.9
16174	Mar. 2	Distinct, clayey.	Slight, earthy.	0.70	3.50	1.10	.0022	.0220	.0184	.0036	.18	.0070	.0002	0.64	0.5
16345	Apr. 1	Slight.	Slight.	0.58	2.20	1.00	.0010	.0130	.0112	.0018	.18	.0050	.0001	0.56	0.6
16529	May 4	Distinct, green.	Slight.	1.00	4.25	2.05	.0026	.0262	.0248	.0014	.37	.0060	.0002	0.82	0.9
16701	June 1	Distinct, clayey.	Slight, brown.	0.90	4.05	1.85	.0028	.0296	.0276	.0020	.31	.0070	.0000	0.80	0.8
16906	July 1	Slight.	Slight.	1.00	4.20	[redacted]	.0018	.0244	.0230	.0014	.25	.0050	.0001	–	0.0
17115	Aug. 3	Distinct.	Cons.	0.57	4.00	[redacted]	.0006	.0218	.0188	.0030	.30	.0050	.0000	0.62	0.9
17329	Sept. 1	Slight.	Slight.	0.40	3.75	1.70	.0000	.0194	.0166	.0028	.33	.0020	[redacted]	0.53	1.2
17574	Oct. 1	V. slight.	Slight.	1.10	4.65	2.50	.0006	.0870	.0805	.0062	.21	.0030	.0001	1.12	1.1
17766	Nov. 2	V. slight.	Cons.	1.00	5.45	2.75	.0002	.0244	.0216	.0028	.47	.0070	.0001	1.39	1.4
17979	Dec. 1	V. slight.	Slight.	1.10	5.20	2.40	.0004	.0364	.0338	.0026	.36	.0060	.0000	1.62	1.0

Averages by Years.

–	1887*	–	–	1.12	5.27	1.81	.0021	.0312	–	–	.39	.0170	–	–	–
–	1888	–	–	1.19	4.76	2.07	.0018	.0298	–	–	.29	.0108	.0002	–	–
–	1889	–	–	1.25	3.63	1.38	.0013	.0294	.0267	.0027	.30	.0080	[illegible]	–	–
–	1890	–	–	0.81	5.18	2.09	.0014	.0256	.0220	.0036	.35	.0135	.0001	–	1.7
–	1891	–	–	0.88	4.35	1.81	.0006	.0274	.0236	.0038	.36	.0112	.0001	–	1.1
–	1892	–	–	1.00	4.71	2.06	.0006	.0247	.0214	.0033	.28	.0099	.0001	–	1.3
–	1893	–	–	0.99	4.57	2.05	.0019	.0232	.0196	.0036	.34	.0068	.0001	0.63	1.4
–	1894	–	–	1.31	4.66	2.17	.0007	.0231	.0211	.0020	.34	.0059	.0001	1.05	1.2
–	1895	–	–	1.07	4.71	2.20	.0014	.0301	.0276	.0025	.36	.0086	.0001	0.99	1.1
–	1896	–	–	0.85	4.15	1.86	.0012	.0244	.0219	.0025	.29	.0058	.0001	0.92	0.9

* June to December.

NOTE to analyses of 1896: Odor, vegetable and occasionally mouldy, becoming stronger on heating. — The samples were collected from the river, near the old dam at the upper end of Reservoir No. 2, at a depth of 1 foot beneath the surface.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 92.

BOSTON.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Reservoir No. 2, Framingham.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended		Nitrates.	Nitrites.		
	1896.														
15831	Jan. 1	Slight.	Slight.	0.90	5.65	1.50	.0000	.0184	.0162	.0022	.23	.0050	.0000	0.92	0.6
15995	Feb. 3	V. slight	V. slight.	0.85	4.35	1.95	.0004	.0190	.0164	.0026	.26	.0090	.0000	0.86	0.8
16175	Mar. 2	Distinct, clayey.	Slight, earthy.	0.70	3.50	1.55	.0020	.0214	.0168	.0046	.16	.0050	.0002	0.64	0.5
16346	Apr. 1	Slight.	Slight.	0.50	2.95	1.25	.0000	.0152	.0128	.0024	.18	.0070	.0001	0.49	0.8
16530	May 4	Distinct.	Slight.	0.80	3.66	1.75	.0026	.0292	.0256	.0036	.37	.0070	.0002	0 71	0.8
16702	June 1	Distinct.	Slight.	0.75	3.75	1.70	.0006	.0210	.0172	.0038	30	.0050	.0001	0.67	1.0
16906	July 1	Distinct.	Slight.	0.90	4.70	2.30	.0022	.0322	.0300	.0022	.25	.0030	.0001	–	0.9
17116	Aug. 3	Distinct.	Slight.	0.57	3.90	1.60	.0006	.0250	.0224	.0026	.32	.0060	.0000	0.71	0.9
17340	Sept. 1	Distinct	Cons.	0.40	3.70	1.65	.0014	.0212	.0184	.0028	.33	[illegible]	.0001	0.64	1.3
17575	Oct. 1	V. slight.	V. slight.	0.48	4.15	1.95	.0012	.0258	.0206	.0052	.34	.0030	.0001	0.74	0.9
17767	Nov. 2	V. slight	Slight.	1.00	5.40	2.90	.0012	.0272	.0234	.0038	.40	.0050	.0000	1 36	1.3
17980	Dec. 1	V. slight.	Slight.	1.05	5.30	2.80	.0004	.0236	.0196	.0040	.48	.0060	.0000	1.56	1.2

Averages by Years.

–	1887*	–	–	1.09	4.94	1.87	.0015	.0335	–	–	.34	.0045	–	–	–
–	1888	–	–	1.08	[illegible]	2.01	.0005	.0300	–	–	.30	.0102	.0001	–	–
–	1889	–	–	1.04	[illegible]	1.26	.0015	.0296	.0252	.0044	.29	.0075	.0002	–	–
–	1890	–	–	0.77	4.58	1.88	.0010	.0235	.0191	.0044	.28	.0123	.0001	–	1.7
–	1891	–	–	0.72	4.02	1.69	.0004	.0230	.0194	.0036	.24	.0105	.0001	–	1.0
–	1892	–	–	0.89	4.33	1.92	.0004	.0231	.0192	.0039	.29	.0082	.0001	–	1.3
–	1893	–	–	0.96	4.28	1.86	.0010	.0219	.0190	.0029	.31	.0064	.0001	0.81	1.3
–	1894	–	–	1.12	4.36	2.05	.0008	.0216	.0193	.0023	.33	.0068	.0000	0.93	1.3
–	1895	–	–	1.08	4.65	2.05	.0015	.0244	.0211	.0033	.34	.0090	.0001	0.98	1.2
–	1896	–	–	0.74	4.05	1.87	.0011	.0233	.0200	.0033	.30	.0051	.0001	0.84	0.9

* June to December.

NOTE to analyses of 1896: Odor, faintly vegetable, becoming stronger on heating. —— The samples were collected from the reservoir, near the gate-house, at a depth of 8 feet beneath the surface. For monthly record of height of water in this reservoir, see table at end of Boston analyses.

BOSTON.

SUDBURY RIVER SUPPLY. — *Microscopical Examination of Water from Reservoir No. 2, Framingham.*

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	2	4	2	3	6	2	2	4	2	2	5	2
Number of sample,	15831	15995	16175	16346	16530	16702	16906	17116	17340	17575	17767	17980
PLANTS.												
Diatomaceæ,	17	21	38	79	110	276	50	[illegible]	37	68	8	16
Asterionella,	0	2	0	0	0	0	0	0	4	0	0	0
Cyclotella,	0	0	1	0	0	244	48	80	2	14	0	8
Fragilaria,	2	0	4	4	0	0	0	0	0	0	0	0
Melosira,	0	2	7	0	9	0	0	8	6	2	0	0
Meridion,	1	0	2	32	0	2	0	0	0	0	0	0
Navicula,	1	2	3	2	1	0	0	2	4	4	2	0
Stephanodiscus,	0	9	0	0	2	0	0	0	0	0	0	2
Synedra,	9	6	13	28	84	8	2	5	5	4	6	6
Tabellaria,	4	0	8	13	14	22	0	0	16	44	0	0
Algæ,	0	0	0	0	0	4	92	7	24	0	0	0
Cœlastrum,	0	0	0	0	0	0	16	0	0	0	0	0
Glœocystis,	0	0	0	0	0	0	0	0	8	0	0	0
Protococcus,	0	0	0	0	0	4	74	0	16	0	0	0
Raphidium,	0	0	0	0	0	0	0	7	0	0	0	0
Fungi, Crenothrix,	2	3	2	0	0	0	0	0	[illegible]	0	0	[illegible]
ANIMALS.												
Infusoria,	4	18	0	[illegible]	2	4	5	0	2	2	6	[illegible]
Codonella,	0	0	0	0	0	0	0	0	0	0	4	2
Euglena,	0	1	0	0	1	0	0	0	0	0	0	0
Mallomonas,	0	0	0	0	0	2	0	0	2	0	0	0
Peridinium,	4	16	0	0	1	0	0	0	0	2	2	2
Trachelomonas,	0	1	0	0	0	2	0	0	0	0	0	0
Vorticella,	0	0	0	0	0	0	5	0	0	0	0	0
Vermes, Rotifer,	0	0	0	0	1	0	0	0	2	0	0	0
Crustacea, Bosmina,	0	0	0	0	0	.02	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	20	0	40	0	100	20	0	40	80	40	80	15
TOTAL,	43	42	80	[illegible]	218	304	147	142	125	110	94	35

BOSTON.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Walker's Brook, Marlborough.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
15841	Jan. 6	Decided, clayey	Cons., earthy.	0.75	13.40	3.90	.0800	.0240	.0180	.0060	1.76	.2500	.0014	0.66	4.0
15996	Feb. 3	Distinct, clayey	Slight, earthy.	0.50	13.50	4.40	.0688	.0230	.0218	.0012	1.80	.1600	.0008	0.71	4.3
16167	Mar. 2	Decided, clayey.	Cons., earthy.	0.80	10.20	3.10	.0980	.0560	.0350	.0210	1.02	.1780	.0093	0.66	3.1
16338	Apr. 1	Distinct, clayey	Slight, earthy.	0.60	11.96	3.60	.0562	.0262	.0220	.0042	1.36	.2500	.0013	0.57	3.6
16521	May 4	Distinct, green.	Cons.	0.42	12.50	3.45	.0472	.0254	.0190	.0064	1.82	.1100	.0040	0.43	6.2
16692	June 1	Distinct, milky	Cons., earthy.	1.20	13.40	3.65	.0640	.0490	.0380	.0110	1.[illegible]	.1000	.0040	[illegible]	4.7
16898	July 1	Slight, milky.	Slight.	0.20	12.50	3.60	.0086	.0182	.0170	.0012	1.62	.1500	.0100	–	4.3
17103	Aug. 3	Decided, clayey.	Slight, brown.	0.40	23.35	6.65	.0432	.0214	.0196	.0018	4.16	.2000	.0100	0.46	9.1
17325	Sept. 1	Distinct, milky.	Slight.	0.30	10.90	2.85	.0006	.0190	.0174	.0016	1.43	.1150	.0018	0.30	3.2
17563	Oct. 1	Slight.	Slight.	0.50	15.65	3.95	.0136	.0336	.0316	.0020	2.06	.0800	.0030	1.01	6.0
17758	Nov. 2	Slight.	Slight.	0.70	16.50	4.25	.0222	.0216	.0204	.0012	2.99	.1800	.0100	0.77	5.8
17970	Dec. 1	Slight.	Cons., earthy.	0.90	16.15	4.30	.0440	.0304	.0224	.0080	2.33	.1900	.0020	0.93	5.6

Averages by Years.

–	1892	–	–	0.49	16.84	4.35	.0307	.0274	.0225	.0048	2.58	.3975	.0037	–	5.7
–	1893	–	–	0.35	14.06	3.94	.0237	.0257	.0180	.0077	1.96	.1878	.0020	0.39	5.3
–	1894	–	–	0.46	14.14	3.62	.0371	.0217	.0171	.0046	2.05	1988	.0016	0.47	4.9
–	1895	–	–	0.57	14.71	3.79	.0292	.0256	.0214	.0042	2.04	.1768	.0035	0.58	5.1
–	1896	–	–	0.63	14.58	3.97	.0435	.0290	.0226	.0064	1.99	.1576	.0043	0.66	5.0

NOTE to analyses of 1896: Odor, distinctly vegetable and musty.—The samples were collected from the brook, at the first road bridge below Maple Street, about 1 mile south of the centre of the city of Marlborough.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 180.

BOSTON.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Stony Brook, at Head of Reservoir No. 3, Southborough.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15832	Jan. 1	Decided, clayey.	Slight, earthy.	1.10	6.10	2.35	.0015	.0212	.0188	.0024	.44	.0350	.0002	1.39	1.7
16019	Feb. 5	Distinct.	Slight, brown.	0.95	5.25	2.60	.0060	.0312	.0222	.0090	.39	.0400	[redacted]	0.78	1.8
16177	Mar. 2	Decided, clayey.	Cons., earthy.	0.85	4.00	1.45	.0124	.0330	.0220	.0110	.15	.0150	.0003	0.66	0.8
16347	Apr. 1	Distinct, clayey.	Slight, earthy.	0.70	3.95	1.55	.0000	.0186	.0154	.0032	.31	.0200	.0002	0.55	1.1
16531	May 4	Decided, milky	Cons., earthy.	1.25	5.85	2.65	.0052	.0368	.0334	.0034	.37	.0150	.0004	1.05	1.7
16709	June 1	Decided, clayey	Cons., earthy.	1.80	5.10	3.20	.0078	.0560	.0442	.0108	.40	.0100	.0008	1.27	1.7
16907	July 1	Decided, clayey.	Cons., earthy.	1.20	6.70	2.60	.0096	.0350	.0326	.0024	.32	.0100	.0004	–	2.1
17117	Aug. 3	Decided, clayey.	Cons., earthy.	0.18	13.65	2.45	.0160	.0230	.0120	.0110	.44	.0100	.0006	0.51	5.7
17341	Sept. 1	Decided, clayey.	Cons., earthy.	0.55	8.40	2.00	.0012	.0218	.0198	.0020	.46	.0080	.0005	0.47	2.7
17576	Oct. 1	Decided.	Cons., earthy.	0.48	8.85	2.60	.0096	.0452	.0306	.0146	.41	.0120	.0003	0.79	3.0
17768	Nov. 2	Decided, clayey.	Cons., earthy.	1.20	6.80	3.65	.0006	.0344	.0316	.0028	.65	.0280	.0005	1.31	2.6
17981	Dec. 1	Decided, clayey.	Cons., earthy.	1.00	9.10	2.95	.0012	.0258	.0216	.0042	.54	.0220	.0000	1.52	2.8

Averages by Years.

–	1887*	–	–	0.97	7.74	2.36	.0029	.0355	–	–	.74	.0162	–	–	–
–	1888	–	–	1.16	6.25	2.17	.0039	.0312	–	–	.51	.0308	.0004	–	–
–	1889	–	–	1.11	5.04	1.76	.0061	.0308	.0280	.0028	.60	.0275	.0005	–	–
–	1890	–	–	0.72	7.31	2.12	.0083	.0257	.0225	.0032	.56	.0282	.0008	–	2.4
–	1891	–	–	0.86	6.15	2.24	.0047	.0291	.0256	.0035	.69	.0220	.0003	–	2.0
–	1892	–	–	0.96	6.19	2.35	.0015	.0291	.0252	.0039	.49	.0202	.0002	–	1.9
–	1893	–	–	0.96	6.03	2.27	.0027	.0273	.0237	.0036	.50	.0127	.0002	0.83	2.0
–	1894	–	–	1.32	6.41	2.64	.0023	.0302	.0249	.0053	.49	.0151	.0001	1.05	2.0
–	1895	–	–	1.03	6.55	2.80	.0041	.0310	.0266	.0044	.49	.0196	.0003	0.98	2.0
–	1896	–	–	0.94	7.47	2.50	.0060	.0317	.0253	.0064	.41	.0187	.0005	0.94	2.3

* June to December.

NOTE to analyses of 1896: Odor, generally distinctly vegetable and occasionally mouldy. —— The samples were collected from the brook, about 50 feet below the first road above Reservoir No. 3, at a depth of 1 foot beneath the surface.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 132.

BOSTON.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Reservoir No. 3, Framingham.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
15833	Jan. 1	Distinct, clayey.	Slight, earthy.	[illegible]	5.10	1.95	.0032	.0212	.0200	.0012	.36	.0320	.0001	.96	1.7
15998	Feb. 3	Slight, milky.	Slight.	.90	5.50	2.25	.0040	.0176	.0150	.0026	[illegible]	.0450	.0000	.86	1.7
16176	Mar. 2	Opaque, clayey.	Cons., earthy.	.90	5.00	1.70	.0110	.0296	.0218	.0078	.20	.0180	.0003	.88	0.9
16346	Apr. 1	Decided, clayey.	Slight.	.40	3.40	1.15	.0040	.0144	.0122	.0022	.27	.0200	.0002	.40	0.9
16532	May 4	Distinct.	Slight.	.70	4.10	1.65	.0028	.0216	.0204	.0012	.35	.0120	.0003	.59	1.3
16704	June 1	Decided.	Cons.	.80	4.40	1.75	.0032	.0274	.0196	.0078	.36	.0070	.0001	.67	1.4
16908	July 1	Distinct.	Cons., white	.72	5.40	2.25	.0012	.0266	.0216	.0050	.32	.0030	.0002	-	1.7
17118	Aug. 3	Decided.	Cons.	.68	5.10	1.65	.0006	.0268	.0212	.0056	.38	.0000	.0000	.75	1.9
17342	Sept. 1	Decided, green.	Cons.	.40	4.45	1.70	.0014	.0282	.0220	.0062	.39	.0080	.0001	.59	1.9
17577	Oct. 1	Distinct.	Slight.	.32	5.75	1.70	.0020	.0274	.0220	.0066	.42	.0050	.0001	.58	2.1
17760	Nov. 2	Slight, milky.	Cons.	.48	5.05	2.10	.0016	.0198	.0184	.0014	.42	.0100	.0000	.57	2.3
17932	Dec. 1	Distinct.	Slight.	.68	6.35	1.90	.0014	.0202	.0176	.0026	.54	.0180	.0001	.72	2.3

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Albuminoid Dissolved.	Albuminoid Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1887*	-	-	.91	5.48	2.02	.0072	[illegible]	-	-	.48	.0170	-	-	-
-	1888	-	-	.98	4.98	1.79	.0088	.0256	-	-	.40	.0213	.0003	-	-
-	1889	-	-	.34	4.89	1.60	.0042	.0306	.0254	.0052	.42	.0182	.0003	-	-
-	1890	-	-	.62	5.40	1.64	.0020	.0239	.0197	.0041	.40	.0229	.0002	-	2.0
-	1891	-	-	.60	4.76	1.66	.0032	.0242	.0200	.0042	.38	.0190	.0002	-	1.7
-	1892	-	-	.72	5.17	1.97	.0024	.0254	.0219	.0035	.40	.0211	.0001	-	1.8
-	1893	-	-	.90	4.97	2.10	.0028	.0259	.0207	.0052	.37	.0100	.0001	.77	1.7
-	1894	-	-	.97	5.48	2.20	.0018	.0265	.0231	.0034	.41	.0105	.0002	.87	1.9
-	1895	-	-	.88	5.48	2.23	.0027	.0273	.0231	.0042	.41	.0151	.0001	.84	1.8
-	1896	-	-	.66	5.04	1.92	.0030	.0234	.0193	.0041	.37	.0144	.0001	[illegible]	1.7

* June to December.

NOTE to analyses of 1896: Odor, distinctly vegetable, occasionally mouldy. —— The samples were collected from the reservoir, near the gate house, at a depth of 6 feet beneath the surface. For monthly record of height of water in this reservoir, see table at end of Boston analyses. The quality of the water of this source and of Stony Brook may have been affected during much of the year by work incident to the construction of Reservoir No. 5 on Stony Brook, above Reservoir No. 3.

BOSTON.

SUDBURY RIVER SUPPLY. — *Microscopical Examination of Water from Reservoir No. 3, Framingham.*

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	2	4	3	3	6	2	2	4	2	2	3	2
Number of sample,	15883	15996	16176	16348	16582	16704	16908	17118	17342	17577	17769	17982
PLANTS.												
Diatomaceæ,	99	56	4	4	142	11	68	284	122	194	1,212	544
Asterionella,	78	55	0	0	18	0	54	8	36	168	200	84
Cyclotella,	0	0	0	0	0	6	6	184	12	0	56	32
Cymbella,	1	0	0	0	0	0	0	0	0	12	0	0
Diatoma,	0	0	0	0	0	0	0	0	0	0	0	[illegible]
Melosira,	0	0	0	0	0	0	0	0	0	0	60	20
Navicula,	0	0	1	2	1	0	0	0	2	0	0	0
Synedra,	2	1	2	1	32	1	0	16	4	14	0	0
Tabellaria,	18	0	1	1	92	4	8	76	68	0	896	360
Cyanophyceæ,	0	0	0	0	0	1	2	12	92	174	8	0
Anabæna,	0	0	0	0	0	1	0	6	2	4	0	0
Clathrocystis,	0	0	0	0	0	0	2	2	16	0	4	0
Cœlosphærium,	0	0	0	0	0	0	0	4	74	2	0	0
Microcystis,	0	0	0	0	0	0	0	0	0	20	4	0
Oscillaria,	0	0	0	0	0	0	0	0	0	148	0	0
Algæ,	0	0	0	0	2	2	94	31	30	6	10	4
Arthrodesmus,	0	0	0	0	0	0	0	2	4	0	0	0
Chlorococcus,	0	0	0	0	0	0	0	0	2	6	0	0
Cœlastrum,	0	0	0	0	0	0	22	0	0	0	6	0
Pediastrum,	0	0	0	0	0	2	1	4	0	0	0	0
Protococcus,	0	0	0	0	1	0	62	16	4	0	4	0
Raphidium,	0	0	0	0	1	0	2	9	20	0	0	4
Staurogenia,	0	0	0	0	0	0	7	0	0	0	0	0
ANIMALS.												
Rhizopoda, Difflugia,	1	0	0	0	0	0	0	0	1	0	0	0
Infusoria,	0	[illegible]	0	60	2	2	8	4	11	11	0	0
Dinobryon,	0	0	0	0	1	0	0	0	0	11	0	0
Euglena,	0	0	0	60	0	0	0	0	0	0	0	0
Mallomonas,	0	0	0	0	0	0	0	0	6	0	0	0
Trachelomonas,	0	0	0	0	1	0	1	4	5	0	0	0
Vorticella,	0	0	0	0	0	2	7	0	0	0	0	0
Vermes,	0	0	1	0	[illegible]	[illegible]	0	0	2	0	2	0
Anuræa,	0	0	1	0	0	0	0	0	2	0	0	0
Asplanchna,	0	0	0	0	0	0	0	0	0	0	2	0
Conochilus,	0	0	0	0	2	0	0	0	0	0	0	0
Rotifer,	0	0	0	0	0	3	0	0	0	0	0	0
Crustacea,	0	.02	0	0	.06	0	.02	0	0	0	0	0
Cyclops,	0	0	0	0	.04	0	0	0	0	0	0	0
Daphnia,	0	.02	0	0	.02	0	.02	0	0	0	0	0
Miscellaneous, Zoöglœa,	60	0	60	5	40	2	[illegible]	40	60	20	80	70
TOTAL,	160	56	65	69	188	21	176	371	318	395	1,322	618

BOSTON.

COCHITUATE SUPPLY. — *Chemical Examination of Water from Lake Cochituate in Wayland.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	[illegible]														
15834	Jan. 1	Distinct.	Slight.	.30	4.95	1.40	.0024	.0204	.0166	.0038	.46	.0100	.0001	.43	1.9
15997	Feb. 3	Slight.	Slight.	.35	5.70	1.95	.0030	.0156	.0142	.0016	.50	0180	.0000	.51	1.8
16180	Mar. 2	Distinct, clayey.	Slight, clayey.	.57	5.05	1.95	[illegible]	.0186	.0166	.0020	.46	.0180	.0000	.60	1.6
16349	Apr. 1	Distinct, clayey.	Slight.	.42	[illegible]	1.90	.0000	.0166	.0146	.0020	.50	.0200	.0001	.48	1.9
16533	May 4	Distinct.	Slight.	.36	4.80	1.65	.0014	.0176	.0140	.0036	.53	.0180	.0003	.45	1.9
16706	June 1	Decided.	Slight.	[illegible]	4.20	1.75	.0014	.0176	.0142	.0034	.47	.0150	.0002	.52	1.5
16909	July 1	Distinct.	Slight.	.27	5.10	1.65	.0010	.0152	.0142	.0010	.49	.0080	.0003	–	1.9
17119	Aug. 3	Distinct.	Slight.	.16	4.80	1.46	.0004	.0168	.0144	.0024	.50	.0050	.0004	.61	1.8
17342	Sept. 1	Slight.	Slight.	.15	5.15	1.70	.0000	.0198	.0158	.0040	.53	.0030	.0001	.37	1.8
17578	Oct. 1	Slight.	Slight.	.10	3.40	1.30	.0014	.0188	.0138	.0050	.54	[illegible]	.0001	.36	1.7
17770	Nov. 2	Distinct.	Cons.	.20	4.65	1.90	.0000	.0144	.0104	.0040	.50	.0150	.0002	.33	1.9
17984	Dec. 1	Distinct.	Slight.	.23	4.80	1.05	.0024	.0200	.0150	.0050	.57	.0120	.0000	.35	2.1

Averages by Years.

–	1887*	–	–	.21	5.05	1.38	.0017	.0186	–	–	.44	.0096	–	–	–
–	1888	–	–	.19	4.90	1.24	.0033	.0217	–	–	.43	.0127	.0003	–	–
–	1889	–	–	.33	5.08	1.62	.0025	.0210	.0177	.0033	.46	.0206	.0003	–	–
–	1890	–	–	.31	4.74	1.03	.0016	.0184	.0149	.0035	.49	.0206	.0003	–	2.4
–	1891	–	–	.24	4.66	1.44	.0017	.0182	.0145	.0037	.42	.0212	.0003	–	1.8
–	1892	–	–	.18	4.61	1.35	.0018	.0168	.0133	.0035	.48	.0152	.0001	–	2.0
–	1893	–	–	.21	4.64	1.66	.0015	.0168	.0138	.0030	.46	.0098	.0002	.39	2.0
–	1894	–	–	.20	4.76	1.60	.0008	.0163	.0137	.0026	.51	.0070	.0001	.37	2.1
–	1895	–	–	.25	5.06	1.63	.0015	.0178	.0153	.0025	.51	.0112	.0001	.42	2.1
–	1896	–	–	.28	4.80	1.65	.0012	.0176	.0145	.0031	.50	.0122	.0001	.46	1.9

* June to December.

NOTE to analyses of 1896: Odor, generally vegetable, becoming somewhat stronger on heating.—The samples were collected in the gate-house. For monthly record of height of water in this lake, see table at end of Boston analyses.

BOSTON.

Cochituate Supply. — ***Microscopical Examination of Water from Lake Cochituate in Wayland.***

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar	Apr.	May	June	July.	Aug.	Sept	Oct.	Nov.	Dec.
Day of examination,	2	4	4	3	5	2	2	4	2	2	3	3
Number of sample,	15684	15997	16180	16349	16583	16705	16909	17119	17342	17578	17770	17984
PLANTS.												
Diatomaceæ,	986	423	247	204	788	580	97	16	32	952	1,086	2,244
Asterionella,	464	224	137	9	400	14	20	0	0	344	996	1,776
Cyclotella,	5	0	0	1	0	86	45	0	1	84	4	12
Melosira,	406	126	97	192	60	0	0	0	0	4	82	336
Stephanodiscus,	1	3	1	0	68	0	0	0	0	0	2	0
Synedra,	0	20	0	0	88	24	0	76	31	0	2	0
Tabellaria,	108	50	12	2	180	456	37	0	0	520	0	120
Cyanophyceæ,	266	52	15	0	0	6	4	144	141	16	216	30
Anabæna,	0	0	0	0	0	0	4	4	28	14	0	0
Microcystis,	1	0	0	0	0	2	0	140	112	2	10	2
Oscillaria,	265	52	15	0	0	4	0	0	1	0	206	28
Algæ,	1	0	2	0	4	20	7	13	4	52	4	0
Arthrodesmus,	0	0	0	0	0	2	2	0	0	8	0	0
Protococcus,	0	0	1	0	4	10	5	13	4	44	2	0
Raphidium,	1	0	1	0	0	8	0	0	0	0	2	0
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	1	0	0	2	0	0	0	0	0
Infusoria,	0	10	4	30	18	128	2	1	0	3	100	12
Ceratium,	0	0	0	0	0	0	1	0	0	2	0	0
Ciliated infusorian,	0	3	0	0	0	0	0	0	0	0	0	0
Codonella,	0	0	0	0	2	0	0	0	0	0	0	0
Dinobryon,	0	0	1	0	8	120	0	0	0	0	84	0
Euglena,	0	0	0	2	0	0	0	0	0	0	0	0
Mallomonas,	0	1	0	0	2	2	0	1	0	0	4	2
Peridinium,	0	3	1	27	0	0	0	0	0	0	0	0
Trachelomonas,	0	3	2	1	6	0	0	0	0	1	12	10
Uroglena,	0	0	0	0	0	6	1	0	0	0	0	0
Vermes,	0	0	0	0	0	0	0	0	0	6	0	0
Rotatorian ova,	0	0	0	0	0	0	0	0	0	4	0	0
Rotifer,	0	0	0	0	0	0	0	0	0	2	0	0
Crustacea,	0	.04	.02	.10	0	0	.02	0	0	0	.02	0
Cyclops,	0	0	.02	.10	0	0	.02	0	0	0	.02	0
Daphnia,	0	.04	0	0	0	0	0	0	0	0	0	0
Miscellaneous,	5	0	20	60	10	0	3	5	20	40	[illegible]	55
Acarina,	0	.02	0	0	0	0	0	.02	0	0	0	0
Zoöglœa,	5	0	20	60	10	0	3	5	20	40	40	55
Total,	1,261	485	288	295	798	744	115	179	197	1,069	1,448	2,341

BOSTON.

COCHITUATE WORKS. — *Chemical Examination of Water from a Faucet at the Massachusetts Institute of Technology, Boston.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
[illegible]	Jan. 1	V. slight.	V. slight.	.70	4.70	1.75	.0004	.0194	.0168	.0026	.35	.0170	.0000	.66	1.4
16000	Feb. 3	V. slight.	V. slight.	.70	4.75	2.06	.0010	.0172	.0158	.0014	.34	.0280	.0000	.68	1.3
16175	Mar. 2	Slight.	Slight.	.67	4.45	1.90	.0012	.0162	.0148	.0014	.31	.0180	.0001	.58	1.3
16350	Apr. 1	Slight, clayey.	Slight.	.45	4.00	1.60	[redacted]	.0128	.0092	.0036	.30	.0250	.0001	.48	1.1
16534	May 4	Slight.	Slight.	.40	4.00	1.40	.0034	.0144	.0126	.0018	.36	.0250	.0001	.42	1.2
16706	June 1	Distinct.	Slight, brown.	.50	4.06	1.66	.0000	.0162	.0140	.0022	.38	[redacted]		.51	1.4
16910	July 1	Distinct.	Slight.	.40	4.30	1.90	.0000	.0176	.0150	.0026	.34	.0100	.0001	-	1.6
17120	Aug. 3	Distinct.	Slight, brown.	.40	4.00	1.46	.0002	.0154	.0136	.0018	.41	.0110	.0001	.70	1.7
17344	Sept. 1	Slight.	Slight.	.33	4.25	1.65	.0000	.0174	.0144	.0030	.37	.0000	.0001	.47	1.5
17579	Oct. 2	V. slight.	Slight.	.27	3.50	1.30	.0000	.0174	.0158	.0016	.39	.0070	.0001	.44	1.3
17771	Nov. 3	Slight.	Slight.	.40	4.25	1.75	.0000	.0144	.0136	.0008	.38	.0120	.0000	.60	1.5
17983	Dec. 2	V. slight.	Slight.	.63	4.96	1.75	.0002	.0194	.0152	.0042	.49	.0150	.0000	.67	1.9

Averages by Years.

-	1887*	-	-	.35	4.29	1.37	.0002	.0235	-	-	.41	.0094	-	-	-
-	1888	-	-	.38	[redacted]	1.58	.0012	.0215	-	-	.40	.0183	.0008	-	-
-	1889	-	-	.51	4.71	1.43	.0005	.0199	.0176	.0023	.42	.0272	.0002	-	-
-	1890	-	-	.35	4.70	1.28	.0003	.0169	.0148	.0021	.42	.0241	.0001	-	2.2
-	1891	-	-	.37	4.39	1.63	.0005	.0161	.0136	.0025	.37	.0227	.0001	-	1.7
-	1892	-	-	.37	4.70	1.47	.0007	.0168	.0138	.0030	.41	.0210	.0001	-	1.9
-	1893	-	-	.61	4.54	1.84	.0010	.0174	.0147	.0027	.36	.0142	.0001	.60	1.5
-	1894	-	-	[redacted]	4.64	1.83	.0006	.0169	.0150	.0019	.41	.0106	.0001	.63	1.7
-	1895	-	-	.72	4.90	2.02	.0006	.0197	.0175	.0022	[redacted]	.0171	[redacted]	.69	.7
-	1896	-	-	.49	4.29	1.67	.0006	.0165	.0142	.0023	.37	.0155	.0001	.56	1.4

* August to December.

NOTE to analyses of 1896: Odor, generally faintly vegetable, frequently none.

BOSTON.

COCHITUATE WORKS. — *Microscopical Examination of Water from a Faucet at the Massachusetts Institute of Technology, Boston.*

[Number of organisms per cubic centimeter.]

	190[illegible]											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	2	4	4	8	6	3	2	4	3	2	3	2
Number of sample,	15835	16000	16178	16350	16584	16706	16910	17120	17344	17570	17771	17968
PLANTS.												
Diatomaceæ,	170	135	103	[illegible]	206	342	325	57	108	284	416	492
Asterionella,	96	90	44	30	112	7	28	5	20	132	316	368
Cyclotella,	0	0	0	0	1	224	17	0	0	8	6	8
Fragilaria,	0	0	0	0	0	0	11	0	0	0	0	6
Melosira,	44	22	57	68	18	10	5	0	4	28	88	96
Stephanodiscus,	0	0	2	0	24	6	0	0	0	0	4	0
Synedra,	0	2	0	0	24	15	0	30	20	20	44	2
Tabellaria,	30	19	0	0	29	80	264	52	64	96	2	14
Cyanophyceæ,	24	9	5	0	0	6	5	[illegible]	6	24	30	0
Anabæna,	0	0	0	0	0	6	5	3	0	0	0	0
Microcystis,	0	0	0	0	0	0	0	8	6	4	0	0
Oscillaria,	24	9	5	0	0	0	0	0	0	20	30	0
Algæ,	0	1	1	1	2	1	38	[illegible]	7	4	0	0
Cœlastrum,	0	0	0	0	0	0	8	0	0	0	0	0
Protococcus,	0	0	0	1	1	1	26	6	1	4	0	0
Raphidium,	0	1	1	0	0	0	0	3	6	0	0	0
Staurogenia,	0	0	0	0	0	0	4	4	0	0	0	0
ANIMALS.												
Infusoria,	0	1	1	[illegible]	[illegible]	3	0	0	14	0	3	2
Ceratium,	0	0	0	0	0	0	0	0	2	0	0	0
Dinobryon,	0	0	0	0	11	0	0	0	12	0	2	0
Euglena,	0	0	0	5	0	0	0	0	0	0	0	0
Mallomonas,	0	0	0	0	9	0	0	0	0	0	0	0
Peridinium,	0	1	1	7	0	0	0	0	0	0	1	0
Tintinnidium,	0	0	0	0	1	1	0	0	0	0	0	0
Trachelomonas,	0	0	0	0	2	2	0	0	0	0	0	2
Crustacea, Daphnia,	0	0	0	0	.02	0	0	0	0	0	0	0
Miscellaneous,	0	0	0	10	41	83	2	21	40	60	20	2
Sponge spicules,	0	0	0	0	1	3	0	1	0	0	0	2
Zoöglœa,	0	0	0	10	40	80	2	20	40	60	20	0
TOTAL,	194	144	110	111	267	485	370	131	175	372	453	496

BOSTON.

MYSTIC SUPPLY. — *Chemical Examination of Water from Mystic Lake.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15834	Jan. 1	Distinct, clayey.	Slight.	.23	12.70	3.20	.0580	.0250	.0180	.0070	2.00	.0730	.0011	.40	4.4
15999	Feb. 3	Distinct, clayey.	Slight, earthy.	.26	12.80	3.70	.0870	.0206	.0152	.0054	1.84	.0200	.0008	.37	4.0
16165	Mar. 2	Decided, clayey.	Slight.	.23	10.60	2.65	.0314	.0198	.0152	.0046	1.40	.1100	.0009	.34	3.6
16337	Apr 1	Decided, clayey.	Slight, earthy.	.20	9.15	2.20	.0280	.0174	.0124	.0060	1.60	.0870	.0006	.28	3.4
16537	May 4	Distinct.	Slight.	.25	10.50	2.70	.0110	.0212	.0154	.0058	1.42	.0900	.0013	.26	4.0
16691	June 1	Distinct, white.	Slight, green.	.08	10.95	2.35	.0000	.0256	.0160	.0096	1.50	.0700	.0007	.18	4.0
16914	July 1	Decided, white.	Slight.	.10	12.95	2.55	.0010	.0288	.0128	.0160	1.71	.0300	.0009	–	4.3
17108	Aug. 3	Decided	Slight, green.	.07	12.70	2.36	.0016	.0252	.0120	.0132	1.90	.0200	.0007	.24	4.4
17332	Sept. 1	Decided.	Cons.	.18	13.06	2.35	.0000	.0202	.0128	.0074	1.99	.0220	.0010	.22	5.0
17569	Oct. 1	Distinct.	Slight.	.06	13.30	1.90	.0000	.0262	.0142	.0120	1.86	[illegible]	.0012	.25	5.0
17757	Nov. 2	Decided	Slight.	.06	13.16	2.45	.0002	.0174	.0084	.0090	1.74	.0900	.0001	.25	5.0
17971	Dec. 1	Slight, green.	Slight, green.	.06	8.55	1 20	.0186	.0168	.0086	.0082	1.72	.0650	.0005	.23	4.6

Averages by Years.

–	1887*	–	–	.28	10.82	1.62	.0114	.0266	–	–	2.06	.0263	–	–	–
–	1888	–	–	.21	10.12	1.76	.0244	.0267	–	–	1.94	.0433	.0016	–	–
–	1889	–	–	.26	9.02	1.97	.0211	.0278	.0209	.0069	1.67	.0586	.0012	–	–
–	1890	–	–	.18	10.65	1 78	.0197	.0223	.0183	.0040	1.57	.0796	.0006	–	3.7
–	1891	–	–	.13	9.50	1.61	.0186	.0242	.0187	.0056	1.58	.0731	.0012	–	3.5
–	1892	–	–	.07	11.52	2.09	.0185	.0206	.0153	.0053	2.22	.0696	.0007	–	4.1
–	1893	–	–	.10	12.02	2.17	.0240	.0215	.0159	.0066	2.49	.0563	.0007	.27	4.4
–	1894	–	–	.11	15.60	2.56	.0381	.0235	.0168	.0067	3.46	.0583	.0012	.26	5.2
–	1895	–	–	.18	16.07	2.96	.0650	.0271	.0197	.0074	3 25	.0585	.0016	.32	5.4
–	1896	–	–	.15	11.71	2.46	.0156	.0220	.0134	.0086	1.68	.0569	.0008	.27	4.3

* June to December.

NOTE to analyses of 1896 Odor, generally vegetable or unpleasant, frequently mouldy or fishy. —— The samples were collected from the lake, near the gate-house. For monthly record of height of water in this lake, see table at end of Boston analyses.

BOSTON.

MYSTIC SUPPLY. — *Microscopical Examination of Water from Mystic Lake.*

[Number of organisms per cubic centimeter.]

	1896.											
	Jan	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct	Nov.	Dec.
Day of examination,	2	4	2	3	5	2	3	4	2	2	3	2
Number of sample,	15824	15999	16165	16337	16537	16691	16914	17168	17333	17569	17757	17971
PLANTS.												
Diatomaceæ,	80	5	7	17	182	175	64	4,000	[illegible]	8	28	8
Asterionella,	[illegible]	0	0	8	2	2	0	0	0	0	4	0
Melosira,	[illegible]	3	0	0	0	0	0	0	0	0	0	4
Navicula,	0	0	0	1	0	1	0	0	0	6	0	0
Synedra,	76	2	7	8	180	172	64	4,000	800	2	24	4
Cyanophyceæ,	0	0	0	0	0	8	0	0	0	0	[illegible]	22
Anabæna,	0	0	0	0	0	0	0	0	0	0	14	22
Microcystis,	0	0	0	0	0	8	0	0	0	0	0	0
Algæ,	14	3	0	8	103	202	105	960	500	784	62	60
Protococcus,	0	0	0	3	3	0	0	0	0	400	6	24
Raphidium,	1	0	0	1	0	0	5	320	0	0	0	0
Scenedesmus,	8	3	0	3	72	202	100	640	500	384	56	36
Zoöspores,	5	0	0	1	28	0	0	0	0	0	0	0
ANIMALS.												
Infusoria,	0	1	0	11	12	2	2	400	280	8	0	6
Dinobryon,	0	0	0	0	10	0	0	0	0	0	0	0
Euglena,	0	0	0	5	2	2	1	0	0	0	0	0
Monas,	0	0	0	2	0	0	1	0	0	4	0	4
Peridinium,	0	1	0	3	0	0	0	400	280	0	0	0
Phacus,	0	0	0	0	0	0	0	0	0	0	0	2
Trachelomonas,	0	0	0	1	0	0	0	0	0	4	0	0
Vermes, Anurea,	0	0	0	[illegible]	0	0	6	0	0	0	0	0
Miscellaneous, Zoöglœa,	120	60	40	60	80	60	10	40	[illegible]	80	180	48
TOTAL,	214	69	47	96	377	637	187	5,400	1,610	880	284	144

BOSTON.

Table showing Monthly Heights in Feet above Tide-marsh Level of the Water in the Lakes and Storage Reservoirs of the Boston Water Works, from which Samples of Water were collected during the Year 1896.

1896.	Reservoir No. 2. Flash Boards, 167.12.	Reservoir No. 3. Stone Crest, 175.24.	Reservoir No. 4. Flash Boards, 215.21.	Reservoir No. 6. Flash Boards, 295.00.	Farm Pond. High Water, 149.25.	Lake Cochituate. High Water, 134.36.	Mystic Lake. High Water, 7.00.
Jan. 1, .	166.17	175.75	213.86	294.39	149.67	132.30	6.05
Feb. 1, .	166.16	175.48	214.51	294.27	149.80	132.40	6.54
March 1, .	167.33	176.53	215.38	295.27	149.54	133.66	6.71
April 1, .	166.37	175.80	214.78	294.56	149.54	133.92	6.65
May 1, .	167.35	175.44	215.20	294.96	149.44	134.25	6.72
June 1, .	166.65	172.58	215.24	295.13	149.18	133.27	5.53
July 1, .	162.40	173.02	213.70	294.76	148.95	132.22	4.11
Aug. 1, .	162.73	168.55	198.52	294.64	148.59	130.55	0.56
Sept. 1, .	162.73	168.33	185.22	282.24	148.25	128.92	—3.07
Oct. 1, .	162.82	171.36	182.25	270.93	148.59	128.25	1.35
Nov. 1, .	163.54	174.75	186.79	268.45	148.72	127.90	2.35
Dec. 1, .	163.70	176.50	190.78	264.18	148.83	127.80	5.51

WATER SUPPLY OF BRADFORD.

Works for supplying the town of Bradford with water from Johnson's Pond, in the towns of Boxford and Groveland, were completed in March, 1896, and the former sources of supply, consisting of wells on Porter's Island and the southerly shore of the Merrimack River below Bradford and Haverhill, were abandoned on account of the poor quality of the water. The deterioration of the water of these wells, as shown by chemical analyses, has been noted in the previous reports.

Johnson's Pond, the new source of supply, has an area of 222 acres, a maximum depth of 32 feet and an average depth of 14 feet. Its total capacity is about 1,000,000,000 gallons. The shores of the pond and a large portion of the bottom are sandy. In the deeper portions the bottom is said to be muddy, but the area of muddy bottom is said to be small compared with the total area of the pond. The area of the watershed, as measured on the State map, is about 4.9 square miles, including the area of the pond and of Chadwick's Pond, which is included within the watershed. The watershed is for the most part high gravelly land, with a very limited

area of swamp land, and the population on the watershed is small in comparison with its area. Several houses, occupied for the most part in the summer season, are located near the shores of the pond, and the advice of the State Board of Health with reference to the protection of the purity of the water supply from danger of pollution by these houses may be found on pages 70 and 71 of this volume.

Chemical Examination of Water from the Wells of the Bradford Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1896.												
15566	Jan. 10	Distinct, milky.	Cons., rusty.	.60	5.10	.0318	.0022	.31	.0100	.0003	.21	2.3	.2180
16021	Feb. 5	Distinct.	Slight.	.70	6.50	.0498	.0058	.27	.0180	.0003	.41	2.1	.2000

Averages by Years.

-	1889*	-	-	.00	3.95	.0000	.0014	.21	.0400	.0000	-	1.6	-
-	1890†	-	-	.00	5.30	.0002	.0036	.34	.0150	.0001	-	2.6	-
-	1891‡	-	-	.04	5.40	.0000	.0027	.23	0350	.0001	-	1.8	-
-	1892	-	-	.08	6.59	.0262	.0029	.28	.0760	.0008	-	2.4	.1022
-	1893	-	-	.33	5.80	.0297	.0047	.30	0475	.0006	.10	2.5	.0774
-	1894	-	-	.43	[illegible]	.0409	.0056	.28	.0244	.0005	.12	2.4	.1483
-	1895	-	-	.50	5.96	.0552	.0004	.31	.0154	0003	.15	2.4	.2221
-	1896§	-	-	[illegible]	5.80	.0408	.0040	.29	.0140	.0003	.31	2.2	.2090

* July. † October. ‡ April, two samples. § January to July.

NOTE to analyses of 1896: Odor, vegetable. —— The samples were collected from faucets in the town.

Microscopical Examination.

No. 15566. Fungi, *Crenothrix*, 6.
No. 16021. Fungi, *Crenothrix*, 120.

BRADFORD.

Chemical Examination of Water from Johnson's Pond in Boxford and Groveland.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16199	Mar. 6	Distinct.	Slight.	.27	4.40	–	.0016	.0142	–	–	[illegible]	.0070	.0000	.33	1.6
16388	Apr. 9	None.	Slight, earthy.	.22	4.10	1.55	.0000	.0134	.0108	.0026	.37	.0030	.0000	.32	1.7
16553	May 6	Slight, milky.	Slight.	.32	4.50	–	.0012	.0140	–	–	.40	.0020	.0000	.31	2.1
16730	June 4	Slight.	Cons., floc.	.36	5.60	–	.0022	.0212	–	–	.36	.0000	[illegible]	.39	2.1
16923	July 6	Distinct.	Slight, rusty.	.25	4.10	1.10	.0004	.0172	.0150	.0022	.38	.0100	.0000	.34	2.2
16954	July 14	Slight.	Slight.	.15	4.55	1.55	.0016	.0228	.0202	.0026	.41	.0000	.0001	–	1.9
17129	Aug 5	Slight.	Slight.	.12	4.90	1.50	.0032	.0232	.0216	.0016	.38	.0050	.0000	.37	2.1
17378	Sept. 9	Slight.	Slight.	.12	4.70	1.25	.0002	.0216	.0174	.0042	.41	.0020	.0000	.28	2.1
17596	Oct. 7	None.	V. slight.	.05	4.10	1.15	.0000	.0184	.0148	.0036	.41	.0030	.0000	.26	1.9
17789	Nov. 5	V. slight.	V. slight.	.10	4.05	1.30	.0008	.0184	.0150	.0034	.42	.0020	.0000	.31	1.9
18001	Dec. 7	V. slight.	V. slight.	.15	4.15	1.20	.0008	.0154	.0126	.0028	.48	.0030	.0000	.25	2.1
Av.	....	....	....	.19	4.52	1.32	.0011	.0186	.0157	.0029	.40	.0042	.0000	.32	2.0

Odor, generally faintly vegetable or mouldy.—Nos. 16954, 17129 and 17378 were collected from the pond, near the point from which the supply of Bradford is drawn, and the others from faucets in the town.

Microscopical Examination of Water from Johnson's Pond in Boxford and Groveland.

[Number of organisms per cubic centimeter.]

	1896.										
	Mar.	Apr.	May.	June.	July.	July.	Aug.	Sept.	Oct.	Nov	Dec.
Day of examination,	–	10	7	6	7	16	[illegible]	9	8	5	8
Number of sample,	16199	16388	16553	16730	16923	16954	17129	17378	17596	17789	18001
PLANTS.											
Diatomaceæ,	–	42	202	7	2	3	[illegible]	17	38	96	8
Asterionella,	–	27	180	0	0	0	0	12	30	84	2
Cyclotella,	–	0	0	7	2	0	0	0	0	2	0
Melosira,	–	0	0	0	0	0	0	4	4	0	0
Stephanodiscus,	–	1	11	0	0	0	0	0	0	0	2
Synedra,	–	13	6	0	0	0	0	1	4	10	4
Tabellaria,	–	1	5	0	0	0	0	0	0	0	0
Cyanophyceæ,	–	0	0	0	8	11	96	4	2	0	0
Anabæna,	–	0	0	0	0	9	60	0	0	0	0
Clathrocystis,	–	0	0	0	8	1	0	0	0	0	0
Microcystis,	–	0	0	0	0	1	36	4	2	0	0
Algæ,	–	0	0	10	5	8	5	1	0	[illegible]	0
Protococcus,	–	0	0	10	0	0	5	1	0	0	0
Staurastrum,	–	0	0	0	5	8	0	0	0	0	0

BRADFORD.

***Microscopical Examination of Water from Johnson's Pond in Boxford and Groveland* — Concluded.**

[Number of organisms per cubic centimeter.]

	1896.										
	Mar.	Apr.	May.	June.	July.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.											
Infusoria,	–	304	2	10	1	1	0	6	4	32	3
Ceratium,	–	0	0	pr.	1	1	0	3	0	0	0
Codonella,	–	2	0	0	0	0	0	0	0	0	0
Dinobryon,	–	301	2	10	0	0	0	0	4	30	2
Peridinium,	–	1	0	0	0	0	0	0	0	2	0
Trachelomonas,	–	0	0	0	0	0	0	3	0	0	0
Vermes, Polyarthra,	–	0	0	0	0	0	1	0	0	0	0
Crustacea,	–	0	.10	.04	0	0	0	0	0	0	0
Bosmina,	–	0	.02	0	0	0	0	0	0	0	0
Cyclops,	–	0	.08	.04	0	0	0	0	0	0	0
Miscellaneous,	–	0	.02	0	0	0	20	20	5	5	0
Acarina,	–	0	.02	0	0	0	.06	0	0	0	0
Zoöglœa,	–	0	0	0	0	0	20	20	5	5	0
TOTAL,	–	346	204	27	16	29	123	48	49	183	16

Chemical Examination of Water from Johnson's Pond, at its Outlet in Groveland.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16065	July 14	Distinct.	Cons., rusty.	.22	5.10	1.85	.0020	.0348	.0324	.0024	.35	.0000	.0000	–	2.4

Odor, unpleasant. —— The sample was collected from the pond, at its outlet.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

BRAINTREE.

WATER SUPPLY OF BRAINTREE.

The advice of the State Board of Health to the town of Braintree relative to increasing the water supply of the town by taking water from tubular wells located on the shore of Little Pond, a short distance north of the present filter-gallery, may be found on pages 11 to 14 of this volume. Analyses of samples of water from the filter-gallery and from tubular test wells along the easterly shore of the pond, near the filter-gallery, are given in the following tables: —

Chemical Examination of Water from the Filter-gallery of the Braintree Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15663	Jan. 9	V. slight, rusty.	Slight, rusty.	.02	5.90	.0004	.0038	.94	.0600	.0000	.05	2.1	.0050
16196	Mar. 5	None.	V. slight.	.18	6.60	.0002	.0068	.82	.0650	.0000	19	1.9	.0280
16547	May 6	None.	None.	.10	4.20	.0000	.0040	.80	.0280	.0000	17	1.5	.0060
16921	July 6	V. slight, milky.	V. slight.	.12	5.40	.0000	.0044	.92	.0170	.0002	–	1.5	.0940
17095	July 29	None.	None.	.05	4.60	.0000	.0050	.83	.0120	.0000	.12	1.6	.0060
17408	Sept. 9	None.	None.	.07	5.60	.0022	.0074	.84	.0050	.0000	.18	1.4	.0010
17865	Nov. 13	None.	V. slight.	.02	6.00	.0008	.0042	.92	.0250	.0001	.06	2.0	.0040

Averages by Years.

–	–*	–	–	.07	7.14	.0006	.0045	.85	.0048	.0008	–	–	–
–	1892	–	–	.02	4.69	.0009	.0030	.75	.0192	.0001	–	1.8	.0343
–	1893	–	–	.03	4.72	.0002	.0049	.83	.0368	.0001	10	1.8	.0097
–	1894	–	–	.04	5.19	.0004	.0046	.86	.0338	.0001	10	1.7	.0125
–	1895	–	–	12	5.82	.0004	.0060	.89	.0309	.0002	[illegible]	2.0	.0417
–	1896†	–	–	.08	5.55	.0006	.0051	.86	.0329	[illegible]	12	1.7	.0096

* June, 1887, to May, 1888.

† Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1896 Odor, none. A faintly vegetable odor was developed on heating the samples collected in March, May and November. —— No. 17408 was collected from the filter-gallery and the others from a faucet at the pumping station.

Microscopical Examination.

An insignificant number of organisms was found in Nos. 15663 and 16196; no organisms were found in the other samples.

BRAINTREE.

Chemical Examination of Water from Tubular Test Wells near Little Pond, Braintree.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	[illegible]	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1906.												
17004	July 29	Decided, clayey.	Cons., sandy.	.05	5.10	.0000	.0024	0.87	.0220	.0000	.04	1.9	.0200
18104	Dec. 12	Slight, clayey.	Cons., earthy.	.00	5.70	.0008	.0020	1.14	.1400	.0001	.01	2.4	.0140
18105	Dec 12	Slight, clayey.	Cons., earthy.	.00	7.10	.0006	.0012	1.16	.1250	.0001	.05	2.6	.1000
18106	Dec. 12	Slight, clayey.	Cons., earthy.	.02	4.90	.0004	.0044	0.96	.0400	.0001	.10	1.6	.0450

Odor, none, becoming faintly earthy or mouldy on heating. —— The samples were collected from tubular wells located on the easterly shore of Little Pond, 17 feet from the high-water mark, as follows: the first sample, from a two-inch test well 195 feet north of the filter-gallery of the Braintree Water Works; the last three samples, from six-inch tubular wells located 140, 165 and 190 feet north of the filter-gallery.

Microscopical Examination.

No. 17004. Fungi, *Crenothrix*, 1,600. No organisms were found in the remaining samples.

Water Supply of Bridgewater and East Bridgewater. — The Bridgewaters Water Company.

Chemical Examination of Water from the Wells of the Bridgewaters Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1906.												
16686	June 24	Distinct, milky.	Slight.	.10	6.60	.0000	.0008	.39	.0050	.0000	.04	2.2	.0260

Odor, none. —— The sample was collected from a faucet at the pumping station.

Microscopical Examination.

Fungi, *Crenothrix*, 600.

Water Supply of Brockton.

In connection with an investigation with reference to an additional water supply for the city of Brockton, samples of water from several

BROCKTON.

ponds and streams in towns in the vicinity of the city have been analyzed. For the results of the analyses, see Abington, Hanson, Pembroke and Kingston.

Chemical Examination of Water from Salisbury Brook Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
15867	Jan 13	Slight.	V. slight.	1.00	3.95	1.90	.0008	.0206	.0196	.0010	.34	.0070	.0001	.94	0.8
16030	Feb. 10	Slight.	Slight.	0.85	4.45	1.70	.0016	.0194	.0178	.0016	.33	.0050	.0001	.69	1.0
16209	Mar. 9	V. slight.	V. slight.	0.70	3.55	1.40	.0004	.0146	.0134	.0012	.34	.0030	.0000	.60	0.3
16358	Apr. 6	Slight.	Slight.	0.50	2.75	1.10	.0000	.0154	.0140	.0014	.29	.0000	.0000	.47	0.5
16567	May 11	Distinct.	Slight.	0.43	2.85	1.30	.0000	.0220	.0130	.0090	.37	.0020	.0000	.49	0.5
16743	June 8	Slight.	Slight, rusty.	0.60	3.10	1.40	.0022	.0236	.0212	.0024	.32	.0000	.0000	.65	0.5
16951	July 6	Distinct.	Cons.	0.70	3.15	1.45	.0002	.0218	.0184	.0034	.59	.0050	.0000	.78	0.4
17167	Aug. 10	Distinct.	Cons.	0.50	3.40	1.40	.0016	.0234	.0210	.0024	.40	.0000	.0001	.62	0.6
17387	Sept. 7	Distinct.	Cons., brown.	0.48	3.80	1.45	.0000	.0250	.0196	.0054	.40	.0030	.0001	.45	0.4
17595	Oct. 6	Slight.	Slight.	0.40	3.65	1.70	.0020	.0282	.0226	.0056	.42	.0000	.0000	.59	0.2
17807	Nov. 9	Distinct.	Slight.	0.67	3.95	2.00	.0000	.0264	.0228	.0036	.45	.0020	.0000	[illegible]	0.6
18006	Dec. 7	Distinct.	Slight.	0.85	4.50	1.80	.0000	.0280	.0200	.0080	.55	.0000	.0000	.82	1.2

Averages by Years.

-	1887*	-	-	.99	4.94	2.25	.0033	.0541	-	-	.33	.0069	-	-	-
-	1888	-	-	.76	3.76	1.61	.0031	.0369	-	-	.31	.0056	.0001	-	-
-	1889	-	-	.78	2.79	1.01	.0028	.0306	.0218	.0088	.30	.0048	.0002	-	-
-	1890	-	-	.75	4.07	1.98	.0016	.0274	.0219	.0055	.32	.0063	.0001	-	0.9
-	1891	-	-	.62	3.15	1.45	.0010	.0215	.0169	.0044	.28	.0061	.0001	-	0.6
-	1892	-	-	.55	3.41	1.37	.0004	.0213	.0168	.0046	.36	.0030	.0000	-	0.7
-	1893	-	-	.67	3.59	1.70	.0007	.0237	.0196	.0041	.40	.0019	.0001	.65	0.7
-	1894	-	-	.81	3.71	1.63	.0012	.0228	.0188	.0040	.44	.0021	.0000	.66	0.7
-	1895	-	-	.80	3.75	1.86	.0009	.0263	.0224	.0039	.43	.0018	.0000	.74	0.9
-	1896	-	-	.64	[illegible]	1.55	.0007	.0224	.0186	.0038	.38	.0022	.0000	.66	0.6

* June to December.

Note to analyses of 1896: Odor, vegetable or mouldy.——The samples were collected from the reservoir, near the gate-house, 1 foot beneath the surface. For monthly record of height of water in this reservoir, see page 128.

BROCKTON.

Microscopical Examination of Water from Salisbury Brook Storage Reservoir.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	15	11	10	7	12	11	9	11	9	8	10	8
Number of sample,	15867	16080	16209	16358	16567	16743	16951	17167	17387	17595	17807	18006
PLANTS.												
Diatomaceæ,	41	66	123	[illegible]	1,137	1,032	1,585	136	392	[illegible]	1,804	[illegible]
Asterionella,	28	49	116	400	1,000	224	21	22	104	260	168	48
Cyclotella,	0	0	0	0	0	0	60	0	0	0	0	0
Diatoma,	0	0	0	0	0	0	0	0	4	4	4	0
Eunotia,	0	0	0	0	0	800	0	0	0	0	0	0
Melosira,	0	0	5	0	21	8	0	0	70	432	16	76
Nitzschia,	0	0	0	1	0	0	0	2	0	4	0	0
Stephanodiscus,	0	0	0	0	0	0	0	0	0	0	2	4
Synedra,	2	17	1	2	40	0	0	6	6	212	4	4
Tabellaria,	11	0	1	21	76	0	1,504	106	208	384	1,658	52
Algæ,	8	1	0	3	18	0	18	8	2	10	38	32
Conferva,	0	0	0	0	0	0	0	0	0	0	8	24
Eudorina,	0	0	0	0	0	0	0	4	0	0	0	0
Protococcus,	0	0	0	0	17	0	0	2	0	2	0	0
Raphidium,	0	1	0	0	0	0	17	0	0	8	0	0
Staurastrum,	0	0	0	0	0	0	1	0	2	0	4	0
Staurogenia,	0	0	0	0	0	0	1	0	0	0	12	0
Zoöspores,	8	0	0	3	1	0	0	0	0	0	14	8
ANIMALS.												
Infusoria,	4	2	412	328	16	3	10	0	14	8	43	96
Ciliated infusorian,	0	0	0	0	0	0	0	0	0	0	0	2
Codonella,	0	0	0	0	0	1	0	0	0	2	1	0
Cryptomonas,	0	0	0	0	0	0	0	0	0	0	8	8
Dinobryon,	0	0	408	324	0	0	0	0	8	0	0	0
Euglena,	0	0	0	0	0	0	3	0	0	0	2	0
Mallomonas,	0	0	0	0	1	0	0	0	0	0	2	0
Monas,	0	0	0	0	0	0	[illegible]	0	0	0	0	8
Peridinium,	4	2	4	4	7	0	2	0	6	0	28	80
Phacus,	0	0	0	0	4	0	0	0	0	0	0	0
Trachelomonas,	0	0	0	0	4	2	5	0	2	4	2	0
Vermes,	0	0	1	[illegible]	2	1	1	2	0	4	2	4
Anuræa,	0	0	0	0	0	0	0	2	0	2	0	0
Asplanchna,	0	0	1	0	1	0	0	0	0	0	2	4
Polyarthra,	0	0	0	0	0	0	0	0	0	2	0	0
Rotifer,	0	0	0	0	1	1	1	0	0	0	0	0
Miscellaneous, Zoöglœa,	0	0	0	0	120	40	10	40	80	70	80	80
TOTAL,	48	69	536	756	1,293	1,076	1,635	188	488	1,386	2,067	398

BROCKTON.

Table showing Height of Water in Salisbury Brook Storage Reservoir, Brockton, on the First Day of Each Month in 1896.

[NOTE. — High-water mark is 14.25 feet.]

DATE.	Height of Water.	DATE.	Height of Water.
1896.	Feet.	1896.	Feet.
Jan. 1, ...	14.66	July 1, ...	14.77
Feb. 1, ...	14.41	Aug. 1, ...	13.17
March 1, ...	14.79	Sept. 1, ...	11.42
April 1,*	15.16	Oct. 1, ...	12.34
May 1, ...	14.95	Nov. 1, ...	14.33
June 1, ...	14.31	Dec. 1, ...	14.43

* About April 1, 1896, the water was raised temporarily 18 inches above high-water mark.

Chemical Examination of Water from Underdrains beneath the Sewers at Brockton.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16277	Mar. 17	Decided.	Cons., rusty.	.16	19.10	.4300	.0080	3.02	.3650	.0027	.42	5.6	.0450
17006	July 16	Distinct, milky.	Slight, rusty.	.28	16.40	.3960	.0190	2.52	.2000	.0050	.33	7.3	.0900
17857	Nov. 11	Distinct.	Cons., floc.	.30	17.40	.4800	.0180	2.40	.3000	.0100	.30	5.9	.1420
Av.	....	....	....	.25	17.63	.4520	.0150	2.65	.2883	.0060	[illegible]	6.3	.0923

Odor, decidedly tarry and unpleasant. — The samples were collected from an underdrain, at its outlet into Salisbury Plain River, at Factory Village.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 513, consisting chiefly of *Crenothrix*.

WATER SUPPLY OF BROOKLINE.

Chemical Examination of Water from a Faucet at the Low-service Pumping Station of the Brookline Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16095	Feb. 19	None.	None.	.02	9.10	.0000	.0024	.55	[redacted]	.0000	.12	4.6	.0030
16400	Apr. 13	None.	None.	.01	8.20	.0002	.0024	.56	.0200	[redacted]	.11	4.0	.0050
16827	June 17	None.	None.	.04	6.60	[redacted]	.0024	.58	.0400	[redacted]	.06	5.1	.0010
17216	Aug. 15	None.	None.	.05	8.50	.0014	.0034	.52	.0180	.0000	.11	4.4	.0010
17620	Oct. 12	None.	None.	.04	8.80	.0010	.0032	.59	.0300	.0000	.11	4.4	.0050
18116	Dec. 14	None.	None.	.05	9.90	.0016	[redacted]	.61	.0400	.0000	.10	4.9	.0000

Averages by Years.

-	1887*	-	-	.00	7.15	.0004	.0028	.55	.0261	-	-	-	-
-	1888	-	-	.04	6.76	.0002	.0049	.52	.0326	.0000	-	-	-
-	1889†	-	-	.03	6.44	.0003	.0039	.54	.0295	.0000	-	-	-
-	1894	-	-	.02	9.01	.0010	.0017	.65	.0306	.0001	.06	4.5	.0036
-	1895	-	-	.02	9.15	.0005	.0028	.60	.0361	.0000	.07	4.4	.0022
-	1896	-	-	.03	8.48	.0007	.0031	.57	.0302	[redacted]	.10	4.6	.0018

* June to December. † January to May.

NOTE to analyses of 1896: Odor, none. —— The samples were collected from a faucet at the low-service pumping station, located near the Charles River, in the West Roxbury district of the city of Boston, and represent a mixture of water from the filter-gallery and tubular wells.

Microscopical Examination.

No organisms.

BROOKLINE.

Chemical Examination of Water from the Covered Reservoir of the Brookline Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
16094	Feb. 19	None.	None.	.02	8.60	.0000	.0028	.54	.0270	.0000	.10	4.0	.0020
16441	Apr. 20	None.	None.	.02	8.80	.0000	.0022	.56	.0380	.0000	.07	4.8	.0020
16829	June 17	None.	None.	.04	7.70	.0000	.0014	.50	.0320	.0000	.05	4.6	.0010
17456	Sept. 15	None.	None.	.02	7.60	.0000	.0036	.58	.0220	0000	.07	4.4	.0020
17631	Oct. 12	None.	None.	.06	9.30	.0006	.0048	.59	.0320	.0000	.14	4.3	.0050
18117	Dec. 14	None.	None.	.05	9.00	.0006	.0052	.61	.0400	.0000	18	4.6	.0000

Averages by Years.

-	[illegible]	-	-	.02	9.15	.0001	[illegible]	.68	.0363	.0000	.06	4.4	.0026
-	1895	-	-	.03	8.90	.0001	.0024	.60	.0346	.0000	.07	4.5	.0032
-	1896	-	-	[illegible]	8.53	.0002	.0033	.56	.0318	.0000	.09	4.4	.0020

NOTE to analyses of 1896: Odor, none. —— The samples were collected from the reservoir.

Microscopical Examination.

An insignificant number of organisms was found in sample No. 17456; no organisms were found in the remaining samples.

Chemical Examination of Water from Charles River, opposite the Filter-gallery of the Brookline Water Works at West Roxbury.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16399	Apr. 13	V. slight.	Slight.	.57	8.35	1.45	.0002	.0164	.0156	.0008	.33	.0030	.0000	.58	1.2

Odor, decidedly vegetable and mouldy.

Microscopical Examination.

The total number of organisms per cubic centimeter found in this sample was 220.

Water Supply of Cambridge.

Chemical Examination of Water from Fresh Pond, Cambridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
15843	Jan. 7	Distinct, clayey	Slight.	.35	6.20	2.20	.0000	.0224	.0184	.0040	.76	.0380	.0004	.44	3.2
16002	Feb. 4	Distinct, clayey	Slight.	.40	8.40	3.15	.0006	.0214	.0198	.0016	.70	.0580	.0003	.51	3.5
16181	Mar. 3	Distinct, clayey.	Slight.	.40	8.40	2.20	.0004	.0216	.0194	.0022	.68	.0320	.0000	.47	3.2
16356	Apr. 6	Distinct.	Slight.	.32	8.05	2.00	.0023	.0196	.0170	.0026	.75	.0780	.0008	.44	3.6
16538	May 5	Distinct.	Cons.	.33	7.50	2.10	.0026	.0252	.0218	.0034	.72	.0500	.0009	.40	3.2
16710	June 2	Decided	Cons., yellow.	.30	7.10	2.10	.0000	.0228	.0154	.0074	.72	.0500	.0007	.41	3.5
16919	July 6	Slight.	Slight, green.	.27	7.55	1.95	.0010	.0240	.0196	.0044	.63	.0370	.0008	.48	3.4
17121	Aug. 4	Distinct.	Slight.	.20	8.75	2.20	.0018	.0176	.0146	.0030	.67	.0250	.0005	.44	3.1
17357	Sept. 2	Distinct	Slight.	.20	6.85	2.00	.0002	.0274	.0186	.0088	.67	.0200	.0005	.39	2.9
17579	Oct. 5	Slight.	Slight.	.14	7.10	1.65	.0012	.0196	.0172	.0024	.69	.0150	.0008	.40	3.2
17775	Nov. 3	Distinct.	Slight.	.23	8.40	1.95	.0128	.0212	.0162	.0050	.75	.0280	.0010	.36	3.5
17985	Dec. 1	Distinct	Cons., brown.	.30	7.90	1.65	.0004	.0210	.0118	.0092	.83	.0200	.0010	.29	4.2

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Free Ammonia.	Albuminoid Total.	Albuminoid Dissolved.	Albuminoid Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
–	1887*	–	–	.04	17.32	1.94	.0105	.0180	–	–	2.11	.0266	–	–	–
–	1888	–	–	.17	11.14	1.79	.0152	.0206	–	–	1.10	.0261	.0007	–	–
–	1889	–	–	.11	9.86	1.83	.0145	.0220	.0170	.0050	0.90	.0334	.0008	–	–
–	1890	–	–	.11	8.00	1.34	.0098	.0221	.0168	.0053	0.83	.0303	.0004	–	4.1
–	1891	–	–	.15	7.94	1.30	.0096	.0235	.0162	.0073	0.75	.0338	.0004	–	3.8
–	1892	–	–	.16	7.23	1.57	.0086	.0210	.0161	.0049	0.67	.0249	.0003	–	3.4
–	1893	–	–	.27	6.66	1.82	.0106	.0202	.0165	.0037	0.58	.0285	.0006	.40	3.2
–	1894	–	–	.30	6.98	1.61	.0063	.0199	.0162	.0037	0.66	.0183	.0007	.41	3.1
–	1895	–	–	.35	7.43	2.15	.0054	.0245	.0189	.0055	0.69	.0221	.0004	.47	3.3
–	1896	–	–	.29	7.68	2.10	.0020	.0220	.0175	.0045	0.72	.0372	.0006	.42	3.4

* June to December.

Note to analyses of 1896: Odor, distinctly vegetable, becoming stronger and sometimes also mouldy or grassy on heating. —— The samples were collected from the pump well at the pumping station. For monthly record of height of water in this pond, see page 136.

CAMBRIDGE.

Microscopical Examination of Water from Fresh Pond, Cambridge.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	[illegible]	5	4	7	6	3	[illegible]	5	3	5	4	3
Number of sample,	15843	16002	16161	16356	16538	16710	16919	17121	17357	17579	17775	17966
PLANTS.												
Diatomaceæ,	2,348	696	379	555	1,105	2,555	292	115	50	80	1,732	1,902
Asterionella,	1,632	676	352	240	332	800	88	0	0	2	48	16
Cyclotella,	0	0	0	20	0	0	10	0	0	0	0	0
Fragilaria,	174	0	0	4	0	4	114	0	0	0	0	0
Melosira,	101	0	0	225	608	2	0	0	0	2	792	1,060
Nitzschia,	0	0	0	0	72	3	0	0	0	0	0	12
Pinnularia,	0	0	0	0	0	0	0	0	0	0	100	0
Stephanodiscus,	364	19	24	60	88	1,600	0	3	0	3	0	520
Synedra,	6	1	0	5	1	6	4	24	50	65	416	0
Tabellaria,	71	0	3	1	4	140	76	88	0	0	376	294
Cyanophyceæ,	44	0	0	0	0	6	20	[illegible]	148	158	0	0
Anabæna,	0	0	0	0	0	3	6	0	8	0	0	0
Clathrocystis,	0	0	0	0	0	1	6	2	2	0	0	0
Cœlosphærium,	0	0	0	0	0	2	0	15	46	66	0	0
Microcystis,	0	0	0	0	0	0	8	48	92	92	0	0
Oscillaria,	44	0	0	0	0	0	0	5	0	0	0	0
Algæ,	7	2	24	7	[illegible]	[illegible]	16	[illegible]	[illegible]	1	12	[illegible]
Protococcus,	7	0	0	5	0	4	10	4	0	0	0	0
Raphidium,	0	0	0	1	0	2	4	0	0	0	0	0
Staurastrum,	0	0	0	1	0	0	2	2	0	1	12	5
Zoöspores,	0	2	24	0	[illegible]	0	0	0	0	0	0	0
ANIMALS.												
Infusoria,	3	1	0	4	1	1	0	3	1	2	8	6
Ceratium,	0	0	0	0	0	0	0	2	1	0	0	0
Codonella,	0	0	0	0	0	1	0	0	0	0	0	1
Epistylis,	0	0	0	0	0	0	0	0	0	0	4	0
Mallomonas,	1	0	0	0	0	0	0	1	0	0	0	0
Trachelomonas,	2	1	0	3	1	0	0	0	0	2	4	4
Vorticella,	0	0	0	1	0	0	0	0	0	0	0	1
Vermes,	0	1	0	0	3	1	0	1	1	0	0	1
Anuræa,	0	1	0	0	1	1	0	0	1	0	0	1
Rotatorian ova,	0	0	0	0	2	0	0	1	0	0	0	0
Crustacea,	[illegible]	0	0	[illegible]	.02	0	0	0	0	0	.06	0
Cyclops,	0	0	0	.04	0	0	0	0	0	0	.04	0
Daphnia,	0	0	0	0	0	0	0	0	0	0	.02	0
Entomostracan ova,	0	0	0	0	.02	0	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	0	40	20	40	20	[illegible]	5	100	60	20	60	40
TOTAL,	2,402	740	423	610	1,129	2,650	333	293	240	253	1,812	2,047

CAMBRIDGE.

Chemical Examination of Water from Stony Brook Storage Reservoir, Waltham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
15849	Jan. 7	Slight.	Slight.	.73	5.70	1.95	.0006	.0220	.0208	.0012	.48	.0400	.0001	.69	1.9
16015	Feb. 4	Slight.	Slight.	.50	6.10	2.80	.0020	.0174	.0152	.0022	.49	.0480	.0001	.64	1.7
16167	Mar. 3	Decided, clayey.	Slight, earthy.	.57	4.40	1.70	.0088	.0276	.0244	.0032	.32	.0260	.0000	.64	1.4
16349	Apr. 6	Slight, clayey.	Slight.	.60	4.35	1.40	.0006	.0232	.0184	.0048	.41	.0280	.0001	.56	1.8
16542	May 5	Slight.	Slight.	.90	6.20	2.20	.0016	.0256	.0244	.0012	.48	.0150	.0001	.78	2.1
16714	June 2	Slight.	Slight.	.80	5.35	2.10	.0010	.0212	.0194	.0018	.44	.0180	.0002	.62	2.5
16920	July 6	Slight.	Slight, green.	.60	5.55	1.95	.0004	.0256	.0228	.0028	.50	.0120	.0004	.74	2.1
17125	Aug. 4	Distinct.	Slight, green.	.43	6.05	1.30	.0008	[redacted]	.0182	.0042	.52	.0070	.0002	.53	2.3
17356	Sept. 3	Distinct.	Slight.	.40	5.65	1.55	.0006	.0276	.0216	.0060	.55	.0020	.0001	.48	2.3
17566	Oct. 5	Slight.	Slight.	.47	7.55	2.40	.0070	.0810	.0290	.0020	.52	.0130	.0004	.70	2.9
17780	Nov. 3	Decided.	Slight.	.66	8.10	2.65	.0046	.0272	.0254	.0018	.54	.0220	.0001	.72	3.0
17993	Dec. 2	Distinct.	Slight.	.66	7.50	2.35	.0033	.0296	.0230	.0066	.63	.0320	.0000	.76	2.8

Averages by Years.

-	1887*	-	-	.81	6.21	1.82	.0049	.0647	-	-	.43	.0035	-	-	-
-	1888	-	-	.76	5.15	1.93	.0031	.0285	-	-	.34	.0169	.0002	-	-
-	1889	-	-	.87	[illegible]	1.47	.0032	.0280	.0249	.0031	.38	.0162	.0003	-	-
-	1890	-	-	.61	5.66	2.02	.0016	.0222	.0182	.0040	.37	.0206	.0002	-	2.3
-	1891	-	-	.56	4.99	1.86	.0016	.0213	.0183	.0030	.34	.0163	.0001	-	1.9
-	1892	-	-	.72	5.45	1.70	.0015	.0241	.0202	.0059	.37	.0208	.0001	-	2.2
-	1893	-	-	.66	5.32	1.97	.0020	.0235	.0196	.0039	.44	.0208	.0001	.60	2.1
-	1894	-	-	.72	5.61	2.03	.0018	.0211	.0189	.0022	.46	.0174	.0001	.64	2.1
-	1895	-	-	.84	6.00	2.41	.0015	.0280	.0235	.0045	.49	.0258	.0001	.79	2.2
-	[illegible]	-	-	.61	5.98	2.08	.0026	.0250	.0219	.0031	.49	.0219	.0001	.65	2.2

* June to November.

Note to analyses of 1896: Odor, distinctly vegetable, frequently becoming mouldy on heating. —— The samples were collected from the reservoir, near the surface, at the dam. For monthly record of height of water in this reservoir, see page 156.

CAMBRIDGE.

Microscopical Examination of Water from Stony Brook Storage Reservoir, Waltham.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.
Day of examination,	8	5	4	7	6	3	7	5	2	6	4	5
Number of sample,	15849	16015	16187	16359	16542	16714	16920	17125	17356	17586	17780	17998
PLANTS.												
Diatomaceæ,	14	1	3	48	33	195	3,432	969	914	60	86	100
Asterionella,	0	1	0	2	0	11	2,112	8	196	10	0	26
Cyclotella,	0	0	0	0	0	168	72	352	0	40	0	0
Fragilaria,	0	0	0	0	0	0	8	0	0	0	0	0
Meridion,	1	0	2	5	0	0	0	2	0	0	0	0
Stephanodiscus,	0	0	0	0	1	0	0	7	0	0	60	22
Synedra,	9	0	0	8	32	2	368	52	6	0	0	12
Tabellaria,	4	0	1	33	0	13	872	548	712	10	26	30
Cyanophyceæ,	0	0	0	0	0	14	6	9	24	24	[illegible]	0
Anabæna,	0	0	0	0	0	11	0	8	17	20	2	0
Clathrocystis,	0	0	0	0	0	3	6	0	2	0	0	0
Cœlosphærium,	0	0	0	0	0	0	0	1	5	4	4	0
Algæ,	0	0	0	1	0	0	[illegible]	42	28	52	42	12
Arthrodesmus,	0	0	0	0	0	0	0	4	20	0	0	0
Protococcus,	0	0	0	1	0	0	0	36	0	0	0	0
Raphidium,	0	0	0	0	0	0	0	2	8	52	42	12
ANIMALS.												
Rhizopoda,	0	0	0	0	0	0	2	2	2	0	[illegible]	0
Arcella,	0	0	0	0	0	0	2	0	0	0	0	0
Difflugia,	0	0	0	0	0	0	0	2	2	0	0	0
Infusoria,	1	0	0	1	59	[illegible]	14	16	5	20	20	0
Ciliated infusorian,	0	0	0	0	0	0	0	0	0	0	2	0
Cryptomonas,	0	0	0	0	0	0	0	0	0	0	2	0
Dinobryon,	1	0	0	0	58	0	0	0	0	0	0	0
Euglena,	0	0	0	0	0	0	6	0	0	0	0	0
Mallomonas,	0	0	0	0	1	0	0	0	5	6	10	0
Peridinium,	0	0	0	0	0	0	0	2	0	0	0	0
Synura,	0	0	0	1	0	0	0	9	0	0	4	0
Trachelomonas,	0	0	0	0	0	0	8	2	0	14	2	0
Vorticella,	0	0	0	0	0	0	0	3	0	0	0	0
Vermes,	0	0	0	0	2	0	2	0	0	0	0	0
Anuræa,	0	0	0	0	0	0	2	0	0	0	0	0
Rotifer,	0	0	0	0	2	0	0	0	0	0	0	0
Crustacea,	0	0	0	0	0	[illegible]	.02	0	0	.02	[illegible]	[illegible]
Entomostracan ova,	0	0	0	0	0	0	.02	0	0	0	0	0
Nauplius,	0	0	0	0	0	0	0	0	0	.02	0	0
Miscellaneous,	0	0	60	5	60	5	10	50	40	15	40	100
Acarina,	0	0	0	0	.02	0	.02	0	.02	0	0	0
Zoöglœa,	0	0	60	5	60	5	10	50	40	15	40	100
TOTAL,	15	1	63	55	154	214	3,466	1,068	1,013	111	194	212

CAMBRIDGE.

Chemical Examination of Water from Hobbs Brook, at Winter Street, Waltham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16002	Jan. 15	Decided, clayey.	Slight, earthy.	0.90	4.70	2.50	.0056	.0210	.0172	.0038	.47	.0340	.0002	0.70	2.5
16052	Feb. 11	Slight.	Slight.	0.90	5.05	2.20	.0020	.0232	.0198	.0034	.27	.0300	.0002	0.75	1.8
16203	Mar. 7	Slight.	Slight.	0.70	5.60	2.10	.0002	.0206	.0192	.0014	.46	.0330	.0000	0.62	1.7
16372	Apr. 7	Slight.	Slight.	0.90	5.20	2.35	.0002	.0232	.0204	.0028	.41	.0380	.0003	0.71	1.8
16543	May 5	Decided, clayey.	Cons., brown	1.20	6.40	3.00	.0086	.0566	.0310	.0256	.47	.0180	.0004	1.04	2.1
16915	July 2	Distinct, clayey.	Cons., earthy.	0.50	8.30	2.60	.0160	.0460	.0272	.0188	.57	.0180	.0004	-	2.6
17139	Aug. 5	V. slight.	Slight.	0.40	6.65	2.10	.0068	.0232	.0188	.0044	.36	.0030	.0001	0.51	3.1
17368	Sept. 3	Slight.	Cons., brown.	0.42	6.25	1.30	.0076	.0240	.0172	.0068	.60	.0020	.0002	0.33	2.9
17590	Oct. 6	Slight.	Slight.	1.10	7.45	3.25	.0006	.0336	.0314	.0022	.41	[illegible]	.0001	1.26	2.5
17810	Nov. 9	Slight.	Slight.	1.40	7.95	4.20	.0004	.0436	.0412	.0024	.46	.0100	.0001	2.22	2.7
17996	Dec. 4	Slight.	Slight.	1.20	8.35	3.45	.0010	.0414	.0336	.0078	.58	.0080	.0001	1.05	3.1

Averages by Years.

-	1894	-	-	0.65	6.66	1.98	.0007	.0214	.0197	.0017	.53	.0194	.0001	0.59	2.5
-	1895	-	-	1.02	6.63	2.67	.0018	.0290	.0261	.0029	.47	.0246	.0001	0.91	2.5
-	1896	-	-	0.87	6.72	2.64	.0046	.0324	.0252	.0072	.46	.0179	.0002	1.01	2.4

NOTE to analyses of 1896: Odor, distinctly vegetable and mouldy, becoming stronger on heating. —— The samples were collected from the brook. The quality of the water of this source and of Stony Brook Reservoir may have been affected during much of the year by work incident to the construction of a storage reservoir upon Hobbs Brook, above the points where the samples were collected.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 84.

CAMBRIDGE.

Table Showing Heights of Water in Fresh Pond and Stony Brook Storage Reservoir on the First Day of Each Month in 1896.

[Heights are in feet above Cambridge city base.]

Date.	Fresh Pond. High Water, 16.88.	Stony Brook Reservoir. Height of Rollway, 81.00.	Date.	Fresh Pond. High Water, 16.88.	Stony Brook Reservoir. Height of Rollway, 81.00.
1896.			1896.		
Jan. 1, ...	13.69	81.48	July 1, ...	15.74	79.58
Feb. 1, ...	13.75	81.29	Aug. 1, ...	15.11	73.45
Mar. 1, ...	14.71	82.38	Sept. 1, ...	14.47	67.23
April 1, ...	16.93	81.70	Oct. 1, ...	14.40	71.34
May 1, ...	[redacted]	[redacted]	Nov. 1, ...	[redacted]	81.17
June 1, ...	16.28	81.15	Dec. 1, ...	11.41	81.23

Water Supply of Canton.

Chemical Examination of Water from the Wells of the Canton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16389	June 24	None.	None.	.00	3.60	.0004	.0002	.38	.0020	.0000	.04	0.9	.0000
17190	Aug. 12	None.	Slight.	.04	[redacted]	.0012	.0020	.46	.0100	.0000	.04	1.4	.0050

Odor, none. —— The first sample was collected from the well at Springdale; the last, from the well at Henry Springs.

Microscopical Examination.

No organisms.

Water Supply of Chelsea.

(See *Boston, Mystic Works.*)

CHESHIRE.

WATER SUPPLY OF CHESHIRE. — CHESHIRE WATER COMPANY.

Chemical Examination of Water from the Reservoir of the Cheshire Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16121	Feb. 24	V. slight.	None.	.08	4.20	.0000	.0014	.06	.0270	.0000	.04	2.5	.0030
16560	May 12	None.	V. slight.	.07	4.55	.0002	.0044	.06	.0070	.0000	.07	3.4	-
16863	June 24	None.	None.	.05	4.50	.0004	.0012	.06	.0060	.0000	.06	3.5	.0040
17267	Aug. 21	V. slight.	Slight.	.05	6.40	.0000	.0016	.07	.0070	.0000	.09	4.0	.0040
17716	Oct. 26	None.	Slight.	.04	3.90	[illegible]	.0058	.07	.0050	.0000	.07	2.3	.0040
18156	Dec. 18	Slight.	Slight.	.02	3.60	.0006	.0016	.10	.0200	.0000	.06	3.0	.0060
Av.	....	....	....	.04	4.52	.0003	.0027	.07	.0123	.0000	.06	3.1	.0042

Odor, none. —— No. 17716 was collected from the reservoir, and the others from a faucet in the village.

Microscopical Examination.

An insignificant number of organisms was found in most of these samples.

WATER SUPPLY OF CHESTER.

Chemical Examination of Water from the Austin Brook Reservoir of the Chester Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16880	June 24	V. slight.	V. slight.	.15	3.15	0.95	.0004	.0040	.0032	.0008	.11	.0100	.0000	.24	1.3

Odor, none. —— The sample was collected from the reservoir.

Microscopical Examination.

No organisms.

CHICOPEE.

WATER SUPPLY OF CHICOPEE.

Chemical Examination of Water from Cooley Brook Reservoir, Chicopee.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16056	Jan. 27	Distinct.	Slight.	0.22	3.90	0.75	.0012	.0182	.0148	.0034	.12	.0060	.0000	33	1.1
16474	Apr 22	Slight.	Slight.	1.00	4.10	1.00	.0028	.0156	0140	.0016	10	.0050	.0000	72	1.3
17067	July 27	Slight.	Cons., brown.	0.70	4.80	1.25	.0026	.0144	.0106	.0038	10	.0070	.0001	76	2.3
17746	Oct. 28	V. slight.	Cons.	0.70	4.65	1.55	.0004	.0114	.0098	.0016	.13	.0050	.0000	.62	1.9

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1894	-	-	.55	4.16	1.08	.0014	.0091	.0072	.0019	.10	.0042	.0000	.44	1.1
-	1895	-	-	.26	3.69	0.92	.0015	.0071	.0045	.0026	.12	.0067	.0000	.23	1.0
-	1896	-	-	.65	4.21	1.14	.0017	.0149	.0123	.0026	.11	.0062	.0000	.61	1.6

NOTE to analyses of 1896: Odor, distinctly vegetable. —— The samples were collected from Cooley Brook Reservoir.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 37.

Chemical Examination of Water from Morton Brook Reservoir, Chicopee.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15957	Jan 27	Distinct.	Slight.	.03	4.00	0.75	.0022	.0136	.0116	.0020	.16	.0070	.0000	.11	1.3
16475	Apr. 22	V slight	Cons., sandy.	.04	3.40	0.35	.0006	.0050	.0040	.0010	.12	.0050	.0000	.07	0.9
17068	July 27	None.	Slight.	.10	4.00	1.15	.0016	0032	.0022	.0010	14	.0070	.0000	.06	1.3
17747	Oct. 28	V. slight	Cons.	.05	4.10	0.75	.0000	.0064	.0042	0022	15	.0050	.0000	.07	1.1

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1894	-	-	.03	3.76	0.59	.0005	.0030	.0023	.0007	.12	.0103	.0000	.06	1.1
-	1895	-	-	.05	3.76	0.61	.0012	.0095	.0079	.0016	.13	.0060	.0000	.07	0.9
-	1896	-	-	.05	3.87	0.75	.0011	.0070	.0055	.0015	.14	.0067	.0000	.08	1.1

NOTE to analyses of 1896: Odor of the first two samples, none, becoming faintly vegetable on heating; of the third, none; of the fourth, faintly vegetable. —— The samples were collected from the reservoir.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 18.

CHICOPEE.

Chemical Examination of Water from Dingle Brook Reservoir, Chicopee.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
17050	1896. July 24	Slight.	Cons.	.25	4.90	1.15	.0004	.0100	.0088	.0012	.23	.0120	.0002	.20	1.4

Averages by Years.

-	1887*	-	-	.36	4.19	0.92	.0006	.0157	-	-	.19	.0076	-	-	-
-	1888	-	-	.13	3.61	0.72	.0013	.0122	-	-	.17	.0153	.0003	-	-
-	1889†	-	-	.13	3.43	0.61	.0008	.0133	.0087	.0046	.14	.0128	.0002	-	-
-	1895	-	-	.24	4.08	1.08	.0020	.0218	.0099	.0119	.26	.0097	.0001	.21	1.2
-	1896	-	-	.25	4.90	1.15	.0004	.0100	.0088	.0012	.23	.0120	.0002	.20	1.4

* June to December. † January to May.

NOTE to analysis of 1896: Odor, none, becoming faintly vegetable on heating. —— The sample was collected from a faucet in Chicopee, supplied from Dingle Brook.

Microscopical Examination.

The total number of organisms per cubic centimeter found in this sample was 436, consisting chiefly of *Dinobryon*.

Chemical Examination of Water from the Powderhorn Brook Reservoir, Chicopee.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
17051	1896. July 24	Slight.	Slight.	[illegible]	3.05	0.55	.0000	.0054	.0042	.0012	.16	.0050	.0000	.13	0.8

Odor, none, becoming very faintly vegetable on heating. —— The sample was collected from a faucet in the village of Willimansett, which is supplied from this reservoir.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

CLINTON.

Water Supply of Clinton.

Chemical Examination of Water from a Faucet in Clinton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1896.														
15909	Jan. 21	V. slight.	V. slight.	.20	3.50	1.35	.0000	.0066	.0056	.0010	19	.0150	.0000	28	1.6
17561	Sept. 28	Slight.	Slight.	.09	3.70	1.00	.0004	.0136	.0098	.0038	.16	.0070	.0001	.31	1.8

Odor of the first sample, none, becoming faintly vegetable on heating; of the second, faintly vegetable, becoming stronger on heating. —— The samples were collected from a faucet in the town.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows: No. 15909, 19; No. 17561, 464.

Chemical Examination of Water from Heywood's Pond, Sterling.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1896.														
17560	Sept. 28	Decided.	Cons.	.57	4.00	2.15	.0006	.0450	.0254	.0196	.18	.0030	.0000	1.08	[illegible]

Odor, vegetable. —— The sample was collected from Heywood's Pond, near the dam.

Microscopical Examination.

No. 17560. Diatomaceæ, *Asterionella*, 26; *Cyclotella*, 5; *Melosira*, 128; *Navicula*, 2; *Synedra*, 16; *Tabellaria*, 63. Algæ, *Staurastrum*, 2,128. Infusoria, *Peridinium*, 2; *Trachelomonas*, 2. Vermes, *Anuræa*, 2; *Polyarthra*, 6. Crustacea, *Cyclops*, .06. Miscellaneous, *Zoöglœa*, 80. Total, 2,481.

Water Supply of Cohasset. — Cohasset Water Company.

The advice of the State Board of Health to the Cohasset Water Company relative to taking an additional supply of water from wells located in the vicinity of a small brook west of Sohier Street in that town may be found on pages 14 and 15 of this volume.

Chemical Examination of Water from the Tubular Wells of the Cohasset Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15853	Jan. 8	Distinct, milky.	Slight.	.27	19.50	.0002	.0012	2.16	.0200	.0000	.08	9.7	.1160
16214	Mar. 5	Distinct, milky.	Slight, rusty.	.10	15.20	.0004	.0030	2.80	.0180	.0000	.06	7.4	.0440
16556	May 7	Distinct.	Slight, rusty.	.12	16.00	.0010	.0006	1.85	.0080	.0000	.03	7.9	.0500
16949	July 8	Distinct, milky.	V. slight, rusty.	.20	15.10	.0004	.0020	1.74	.0000	.0000	–	6.9	.0800
17372	Sept. 8	Distinct, milky.	Slight.	.18	15.20	.0002	.0010	1.86	.0150	.0000	.07	7.4	.0450
17785	Nov. 4	Distinct.	None.	.08	15.60	.0004	.0028	1.88	[illegible]	.0000	.25	8.2	.0770

Averages by Years.

–	1887*	–	–	.00	15.21	.0005	.0016	1.69	.0196	–	–	–	–
–	1888	–	–	.01	15.20	.0001	.0021	1.60	.0311	[illegible]	–	–	–
–	1889†	–	–	.00	11.84	.0001	.0022	1.46	.0230	[illegible]	–	–	–
–	1890‡	–	–	.00	–	.0000	.0049	1.48	.0150	.0003	–	–	–
–	1893	–	–	.16	17.14	.0001	.0007	1.64	.0258	.0001	.04	8.6	.0451
–	1894	–	–	.17	17.94	.0004	.0016	1.77	.0204	.0000	.03	8.4	.0743
–	1895	–	–	.19	17.22	.0002	.0015	1.69	.0211	.0000	.08	8.3	.0689
–	[illegible]	–	–	.16	16.10	.0004	.0018	2.05	.0118	.0000	.09	7.9	.0652

* June to December. † January to May. ‡ February.

Note to analyses of 1896: Odor, none. —— The samples were collected from a faucet at the pumping station, while pumping.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows, No. 15853, 100; No. 16214, 1,200; No. 16556, 360; No. 16949, 100; No. 17372, 22; No. 17785, 0. The organisms consisted chiefly of *Crenothrix*.

COHASSET.

Chemical Examination of Water from Tubular Test Wells in Cohasset.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
17707	Oct. 22	Slight.	Slight, sandy.	0.03	18.30	.0012	.0010	2.20	.4000	.0005	.06	6.1	.0260
17805	Nov. 9	Distinct	Slight.	0.05	10.50	.0012	.0014	1.95	.0250	.0000	.00	4.6	.0130

Odor, none. —— The first sample was collected from a tubular test well located in a meadow west of Sohier Street, about 75 feet north of the New York, New Haven & Hartford Railroad, the second, from a test well about 300 feet south of the railroad. Both test wells are about 1,500 feet west of the pumping station of the Cohasset Water Company.

Microscopical Examination.

No organisms.

Water Supply of Concord and Lincoln.

The organism *Uroglena* appeared in the water of Sandy Pond in the winter and early spring of 1896, imparting to it a disagreeable taste and odor.

Chemical Examination of Water from Sandy Pond, Lincoln.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16042	Feb. 11	V. slight.	V. slight.	.10	2.35	0.60	.0004	.0112	.0098	.0014	.23	.0030	.0001	.22	0.6
16205	Mar. 9	Distinct	Slight.	.10	2.20	0.55	.0032	.0120	.0108	.0012	.24	.0050	.0000	.14	0.2

Odor of the first sample, none, becoming distinctly sweet and grassy on heating; of the second, distinctly vegetable and mouldy. —— The first sample was collected from a faucet in the town; the second, from the pond.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows: No. 16042, 1,002; No. 16205, 562; consisting chiefly of *Dinobryon*.

COTTAGE CITY.

WATER SUPPLY OF COTTAGE CITY. — COTTAGE CITY WATER COMPANY.

Chemical Examination of Water from the Springs of the Cottage City Water Company.

[Parts per 100,000.]

Number.	Date of Collection	Appearance.			Residue on Evaporation	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid		Nitrates.	Nitrites.			
17142	1896. Aug. 5	None.	V. slight.	.06	5.20	.0000	.0016	.96	.0100	.0000	.04	1.9	.0140

Odor, none. —— The sample was collected from a faucet at the pumping station.

Microscopical Examination.

No organisms.

WATER SUPPLY OF DALTON FIRE DISTRICT, DALTON.

Chemical Examination of Water from the Lower Reservoir on Egypt Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total	Loss on Ignition	Free.	Total	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
16861	1896. June 23	V. slight.	V. slight.	.18	2.45	0.70	.0000	.0098	.0084	.0014	.07	.0180	.0002	.37	0.9

Odor, none. —— The sample was collected from the reservoir.

Microscopical Examination.

No. 16861. Diatomaceæ, *Synedra*, 2. Algæ, *Conferva*, 60; *Protococcus*, 5. Total, 67.

DALTON.

Chemical Examination of Water from the Upper Reservoir on Egypt Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16882	June 23	Slight.	Slight.	[illegible]	3.05	0.95	.0006	.0142	.0112	.0030	.11	.0120	.0001	.45	1.3

Odor, faintly vegetable and mouldy. —— The sample was collected from the reservoir.

Microscopical Examination.

Algæ, *Protococcus*, 1,470; *Scenedesmus*, 2. Total, 1,472.

WATER SUPPLY OF DEDHAM. — DEDHAM WATER COMPANY.

Chemical Examination of Water from the Well of the Dedham Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15900	Jan. 20	None.	None.	.00	9.50	.0004	.0018	.88	1400	.0000	.09	4.0	.0020
16253	Mar. 16	None.	None.	.02	8.60	.0000	.0050	.81	1080	.0001	.03	3.5	.0000
16612	May 18	None.	None.	.02	9.40	.0000	.0018	.81	1100	.0000	.01	4.2	0000
17023	July 21	None.	None.	.00	9.40	.0000	.0016	.80	1050	.0000	.04	3.8	.0000
17463	Sept. 15	None.	None.	.01	9.00	.0002	.0014	.76	1100	.0000	.04	3.8	.0040
17806	Nov. 16	None.	None.	.00	9.90	.0004	.0020	.84	1500	.0000	.08	4.0	.0010

Averages by Years.

-	1887*	-	-	.00	10.97	.0002	.0012	.97	.2690	-	-	-	-
-	1888†	-	-	.00	10.38	.0002	.0011	.93	.2810	.0000	-	-	-
-	1889‡	-	-	.00	9.15	.0000	.0020	.93	.1700	.0000	-	-	-
-	1892	-	-	.00	10.65	.0000	.0006	.95	.2952	.0000	-	4.4	.0007
-	1893	-	-	.00	10.14	.0000	.0024	.92	.2325	.0000	.06	4.3	.0000
-	1894	-	-	.01	10.18	.0000	.0017	.88	.2008	.0000	.08	4.0	.0013
-	1895	-	-	.02	9.92	.0002	.0015	.85	.1768	.0000	.04	3.9	.0000
-	1896	-	-	.01	9.30	.0001	.0023	.82	.1205	.0000	.04	3.9	.0012

* June to December. † January to May. ‡ April.

NOTE to analyses of 1896. Odor, none. —— No. 16612 was collected from the well; the other samples were collected from a faucet at the pumping station.

Microscopical Examination.

An insignificant number of organisms was found in No. 16612; no organisms were found in the remaining samples.

Water Supply of East Bridgewater.

(See *Bridgewater*.)

Water Supply of Easthampton.

Chemical Examination of Water from Bassett Brook, Easthampton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15996	Jan. 17	V. slight.	Slight.	.20	3.40	0.65	.0004	.0044	.0026	.0018	.09	.0180	.0000	.15	1.8
16669	May 22	V. slight.	Slight.	.25	3.90	1.05	.0000	.0070	.0060	.0010	.12	.0040	.0001	.16	1.6
17508	Sept. 18	Distinct, clayey.	Slight.	.46	5.60	1.75	.0000	.0180	.0152	.0028	.18	.0030	.0001	.55	1.7

Averages by Years.

–	1894	–	–	.29	3.95	0.92	.0003	.0071	.0057	.0014	.12	.0033	.0000	.29	2.3
–	1895	–	–	.21	4.30	–	.0001	.0063	–	–	.18	.0053	[illegible]	.35	1.9
–	1896	–	–	.31	4.30	1.15	.0001	.0098	.0079	.0019	[illegible]	.0083	[illegible]	.18	1.6

Note to analyses of 1896: Odor, vegetable.——The samples were collected from a faucet at the pumping station.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

Water Supply of North Easton Village District, Easton.

Chemical Examination of Water from the Well of the North Easton Village District.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16679	June 23	None.	Slight, rusty.	.00	4.50	.0000	.0014	.50	.0220	.0000	.03	1.2	.0010

Odor, none.——The sample was collected from a faucet at the pumping station.

Microscopical Examination.

No organisms.

EVERETT.

WATER SUPPLY OF EVERETT.

(See *Boston, Mystic Works.*)

WATER SUPPLY OF FAIRHAVEN. — FAIRHAVEN WATER COMPANY.

Chemical Examination of Water from the Tubular Wells of the Fairhaven Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitra[redacted]	Nitrites.			
	1896.												
15938	Jan. 22	None.	None.	.10	5.80	.0006	.0046	1.01	.0300	.0000	.19	1.5	.0130
16453	Apr. 21	None.	None.	.02	5 70	.0010	.0030	0.99	.0500	.0000	.08	1.7	.0040
16673	May 25	Slight.	Slight.	.33	5.65	.0004	.0066	0.97	.0400	.0000	.26	1.4	-
16753	June 13	None.	None.	.20	5.45	.0000	.0033	0.96	.0350	.0000	.30	1.9	.0050
17016	July 17	None.	None.	.47	6.90	.0002	.0068	0.98	.0300	.0000	.46	2.5	.0130
17246	Aug. 19	None.	None.	.70	[redacted]	.0000	.0060	0.98	.0270	.0006	.66	2.1	.0320
17537	Sept. 21	None.	None.	.37	5.95	.0004	.0078	1.01	.0120	.0000	.51	1.6	.0160
17706	Oct. 21	None.	None.	.30	6.30	.0004	.0058	1.04	.0260	.0000	.37	1.7	.0100
17884	Nov. 17	None.	V. slight.	.20	6.30	.0000	.0028	1.09	.0480	.0000	.22	2.1	.0060
18172	Dec. 21	None.	None.	.07	5.70	.0006	.0032	1.06	.0800	[redacted]	.14	1.9	.0060

Averages by Years.

-	1894	-	-	.04	6.19	.0004	.0024	0.96	.0006	.0002	.07	1.8	.0136
-	1895	-	-	.18	5.52	.0001	.0042	1.02	.0567	.0001	.20	1.7	.0076
-	1896	-	-	.28	6.02	[redacted]	.0055	1.01	.0366	.0000	.33	1.9	.0116

NOTE to analyses of 1896: Odor of Nos. 16673, 17246, 17537 and 18172, faintly vegetable; of the others, none. —— The samples were collected from a faucet at the pumping station.

Microscopical Examination.

An insignificant number of organisms was found in Nos. 16673, 17246 and 17706; no organisms were found in the remaining samples.

Water Supply of Fall River.

Chemical Examination of Water from North Watuppa Lake.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
15954	Jan. 27	None.	V. slight.	.30	3.05	1.20	.0010	.0152	.0130	.0022	.56	.0020	.0000	.34	0.8
16450	Apr. 27	Slight.	Slight.	.25	3.25	1.00	.0014	.0168	.0148	.0020	.55	.0000	.0001	.38	0.6
16451	Apr. 27	Slight.	Slight.	.25	3.20	1.00	.0032	.0182	.0158	.0024	.56	.0050	.0001	.41	0.5
17063	July 27	V. slight.	V. slight.	.20	3.45	1.15	.0008	.0166	.0132	.0034	.63	.0070	.0000	.34	0.8
17713	Oct. 26	V. slight.	V. slight.	.15	3.55	1.20	.0002	.0146	.0132	.0014	.64	.0050	.0000	.33	0.8

Averages by Years.

-	1887*	-	-	.15	3.26	0.96	.0005	.0151	-	-	.58	.0059	-	-	-
-	1888	-	-	.17	3.18	0.93	[illegible]	.0158	-	-	.52	.0057	.0001	-	-
-	1889†	-	-	.27	3.50	1.20	[illegible]	.0164	.0140	.0024	.50	.0076	.0002	-	-
-	1892	-	-	.08	2.95	0.86	.0012	.0130	.0107	.0023	.52	.0117	.0001	-	0.5
-	1894‡	-	-	.25	3.10	1.15	.0007	.0149	.0130	.0019	.53	.0040	.0000	.39	0.5
-	1895§	-	-	.20	3.40	1.17	.0008	.0191	.0161	.0030	.59	.0010	.0000	.45	0.7
-	1896‖	-	-	.22	3.32	1.14	.0011	.0160	.0137	.0023	.61	.0041	.0000	.35	0.7

* June to December. † January to May. ‡ March and April. § February, April and May.
‖ Where more than one analysis was made in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1896: Odor of the first three samples, none, becoming faintly vegetable on heating; of the others, faintly vegetable. —— The first two samples were collected from a faucet at the pumping station; the others, from faucets in the city.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows: No. 15954, 3; No. 16450, 125; No. 16451, 155; No. 17063, 25; No. 17713, 64.

FALL RIVER.

Chemical Examination of Water from North Watuppa and South Watuppa Lakes in Fall River and Westport.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
17920	Nov. 18	Slight.	Slight.	.15	3.20	1.35	.0002	.0170	.0160	.0010	.66	.0050	.0000	.35	0.8
17921	Nov. 18	Slight.	Slight.	.18	3.55	1.45	.0000	.0156	.0116	.0040	.66	.0030	.0001	.35	0.8
17922	Nov. 18	Slight.	Slight.	.18	3.86	1.35	.0004	.0178	.0162	.0016	.67	.0020	.0001	.33	0.8
17923	Nov. 18	Slight.	Slight.	.23	5.75	1.70	.0000	.0232	.0218	.0014	.64	.0030	.0003	.47	1.0
17924	Nov. 18	Slight.	Slight.	.20	5.40	1.25	.0006	.0216	.0188	.0028	.59	.0020	.0001	.37	1.6
17925	Nov. 18	Slight.	Slight.	.30	5.45	1.60	.0008	.0218	.0184	.0034	.58	.0060	.0001	.45	1.5

Odor of the second sample, none; of the others, faintly vegetable. —— The first three samples were collected from North Watuppa Lake, as follows: No. 17920, 1 mile from the northerly end; No. 17921, centre of lake, opposite Ralph's Neck; No. 17922, ½ mile north of the bridge connecting Fall River and Westport. The last three samples were collected from South Watuppa Lake, as follows: No. 17923, at a sand bar near the entrance of the Quequechan River; No. 17924, opposite the boundary line between Massachusetts and Rhode Island; No. 17925, at the southerly end of the lake.

Microscopical Examination of Water from North Watuppa and South Watuppa Lakes in Fall River and Westport.

[Number of organisms per cubic centimeter.]

	1896.					
	Nov.	Nov.	Nov.	Nov.	Nov.	Nov.
Day of examination,	20	20	20	20	20	20
Number of sample,	17920	17921	17922	17923	17924	17925
PLANTS.						
Diatomaceæ,	20	17	18	12	3	8
Cyclotella,	16	16	[illegible]	4	2	5
Navicula,	0	0	0	4	1	1
Synedra,	4	1	0	4	0	2
Cyanophyceæ,	18	14	12	4	8	2
Anabæna,	0	0	0	2	8	0
Microcystis,	18	14	12	2	0	2
Algæ, Chlorococcus,	0	0	0	8	0	0
ANIMALS.						
Infusoria, Peridinium,	0	2	0	0	0	0
Miscellaneous, Zoöglœa,	0	0	0	5	0	5
TOTAL,	38	33	30	29	11	15

FALL RIVER.

Chemical Examination of Water from Stafford Pond, in Tiverton, R. I., and from Sawdy and Devol Ponds, in Westport.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
17926	Nov. 18	Distinct.	Cons.	[illegible]	3.25	1.96	.0004	.0186	.0142	.0044	0.60	.0080	.0000	.12	0.8
17927	Nov. 18	Distinct.	Cons.	.33	3.95	1.70	.0004	.0224	.0210	.0014	0.70	.0050	.0000	.46	0.5
17928	Nov. 18	Slight.	Slight.	.42	4.40	2.15	.0004	.0266	.0244	.0022	0.72	.0020	.0000	.67	0.5

Odor, faintly vegetable. —— The samples were collected as follows: No. 17926, from Stafford Pond, in Tiverton, R. I.; No. 17927, from Sawdy Pond, in Westport; No. 17928, from Devol Pond, in Westport.

Microscopical Examination of Water from Stafford Pond, in Tiverton, R. I., and from Sawdy and Devol Ponds, in Westport.

[Number of organisms per cubic centimeter.]

	1896.		
	November.	November.	November.
Day of examination,	20	20	20
Number of sample,	17926	17927	17928
PLANTS.			
Diatomaceæ,	4,650	100	28
Asterionella,	4,644	0	0
Cyclotella,	2	92	20
Melosira,	4	4	0
Navicula,	0	2	4
Synedra,	0	2	4
Cyanophyceæ, Microcystis,	2	0	0
ANIMALS.			
Rhizopoda, Actinophrys,	2	0	0
Infusoria,	8	0	2
Codonella,	8	0	0
Monas,	0	[illegible]	2
Vermes, Asplanchna,	8	0	1
Miscellaneous, Zoöglœa,	40	40	0
TOTAL,	4,900	140	31

FALL RIVER.

Chemical Examination of Water from the Quequechan River at Fall River.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity	[redacted]	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
17929	1896. Nov.19	Distinct.	Cons.	.27	7.15	2.20	.1040	.0250	.0230	.0020	1.38	.0250	.0040	.49	2.7

Odor, distinctly mouldy and unpleasant. —— The sample was collected from the Quequechan River at Plymouth Avenue bridge, in Fall River.

Microscopical Examination.

Diatomaceæ, *Synedra*, 32. Miscellaneous, *Zoöglœa*, 90. Total, 122.

Water Supply of Fitchburg.

Chemical Examination of Water from Scott Reservoir, Fitchburg.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
16316	[redacted] Mar.24	Distinct.	Slight.	.16	2.00	0.35	.0004	.0242	.0150	.0092	.16	.0050	.0000	.26	0.2
16637	May 19	Distinct.	Slight.	.10	2.25	0.95	.0010	.0138	.0104	.0034	.17	.0050	.0000	.26	0.3
17233	Aug.18	Slight.	Cons.	.13	2.25	1.25	.0000	.0190	.0168	.0022	.18	.0020	.0000	.30	0.2
17882	Nov.17	Distinct.	Cons., green.	.08	2.15	0.65	.0000	.0192	.0116	.0076	.19	.0000	.0000	.27	0.3

Averages by Years.

-	1887*	-	-	.30	3.62	1.01	.0007	.0281	-	-	.15	.0021	-	-	-
-	1888	-	-	.11	2.31	0.79	.0004	.0240	-	-	.15	.0040	.0001	-	-
-	1889	-	-	.09	2.12	0.62	.0008	.0213	.0162	.0051	.18	.0030	.0001	-	-
-	1890	-	-	.10	2.54	1.02	.0010	.0217	.0152	.0065	.18	.0059	.0001	-	0.9
-	1891	-	-	.18	2.56	1.05	.0007	.0146	.0110	.0036	.14	.0062	.0000	-	0.6
-	1892	-	-	.13	2.78	1.16	.0005	.0261	.0198	.0063	.15	.0089	.0000	-	0.5
-	1893	-	-	.10	2.68	1.30	.0001	.0233	.0162	.0071	.17	.0038	.0000	.29	0.4
-	1894	-	-	.14	2.54	1.01	.0007	.0191	.0143	.0048	.16	.0016	.0001	.28	0.2
-	1895	-	-	.16	2.75	1.15	.0007	.0208	.0147	.0066	.20	.0020	.0000	.36	0.4
-	1896	-	-	.11	2.16	0.97	.0003	.0190	.0134	.0056	.17	.0030	.0000	.27	0.2

* June to December.

Note to analyses of 1896: Odor of the third sample, none; of the others, vegetable or mouldy. —— The samples were collected from the reservoir.

FITCHBURG.

Microscopical Examination of Water from Scott Reservoir, Fitchburg.

[Number of organisms per cubic centimeter.]

	1896.			
	March.	May.	August.	November.
Day of examination,	25	22	20	18
Number of sample,	16316	16637	17233	17882
PLANTS.				
Diatomaceæ,	1	127	864	1,480
Asterionella,	0	52	144	0
Cyclotella,	0	0	0	12
Melosira,	0	17	8	1,160
Nitzschia,	0	0	88	0
Pinnularia,	0	0	0	4
Synedra,	1	48	24	12
Tabellaria,	0	10	600	292
Cyanophyceæ, Anabæna,	0	0	5	0
Algæ,	82	0	0	48
Dictyosphærium,	0	0	0	20
Protococcus,	80	0	0	4
Scenedesmus,	2	0	0	4
Staurogenia,	0	0	0	20
ANIMALS.				
Infusoria,	388	100	7	16
Dinobryon,	224	100	0	0
Mallomonas,	76	0	0	0
Monas,	0	0	0	12
Peridinium,	88	0	5	4
Trachelomonas,	0	0	2	0
Vermes,	0	1	1	8
Anurea,	0	0	1	4
Polyarthra,	0	0	0	4
Rotifer,	0	1	0	0
Miscellaneous, Zoöglœa,	20	20	20	100
TOTAL,	491	248	897	1,652

FITCHBURG.

Chemical Examination of Water from Meeting-house Pond, Westminster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15926	Jan. 21	None.	V. slight.	.12	2.70	1.16	.0014	.0142	.0114	.0028	.16	.0060	.0000	.31	0.8
16110	Feb. 19	Slight.	Slight.	.20	3.45	1.20	.0022	.0246	.0234	.0012	.29	.0070	.0000	.40	1.4
16260	Mar. 17	Slight.	Slight.	.20	2.70	1.16	.0022	.0170	.0140	.0030	.18	.0130	.0000	.31	1.1
16636	May 19	Slight.	Slight.	.10	2.45	1.05	.0026	.0194	.0176	.0018	.19	.0050	.0001	.27	0.4
17049	July 22	Slight.	Slight.	.13	2.20	0.55	.0000	.0144	.0124	.0020	.16	.0020	.0000	.16	0.5
17282	Aug. 18	V. slight.	Slight.	.05	2.25	1.25	.0004	.0112	.0094	.0018	.15	.0020	.0000	.20	0.3
17467	Sept. 15	Slight.	Slight.	.10	2.05	0.66	.0004	.0120	.0110	.0010	.19	.0020	.0000	.16	0.3
17888	Nov. 17	V. slight.	V. slight.	.08	2.10	0.70	.0002	.0114	.0106	.0008	.19	.0020	.0000	.19	0.5

Averages by Years.

Number.	Year.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1893	-	-	.07	2.37	0.88	.0009	.0157	.0118	.0024	.17	.0023	.0000	.23	0.6
-	1894	-	-	.07	2.26	0.56	.0011	.0149	.0125	.0024	.18	.0026	.0000	[illegible]	0.6
-	1895	-	-	.10	2.61	0.92	.0012	.0144	.0130	.0014	.20	.0027	.0000	.23	0.8
-	1896	-	-	.12	2.49	1.00	.0018	.0154	.0136	.0016	.19	.0049	.0000	.25	0.6

NOTE to analyses of 1896: Odor, generally faintly vegetable, sometimes none. —— The samples were collected from the pond, at the gate-house.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 20.

WATER SUPPLY OF FOXBOROUGH WATER SUPPLY DISTRICT, FOXBOROUGH.

Chemical Examination of Water from the Tubular Wells of the Foxborough Water Supply District.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
17046	July 22	None.	None.	.02	3.30	[illegible]	.0000	.40	.0420	.0000	.01	0.6	.0000

Odor, none. —— The sample was collected from a faucet at the pumping station, while pumping.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

WATER SUPPLY OF FRAMINGHAM. — FRAMINGHAM WATER COMPANY.

Chemical Examination of Water from the Filter-gallery of the Framingham Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
18073	Feb. 17	V. slight.	Slight.	.04	[redacted]	.0004	.0038	.85	.0200	.0002	.02	2.9	.0100
16565	May 11	V. slight.	Slight.	.06	7.10	.0028	.0040	.90	.0860	.0002	.02	3.0	.0270
17214	Aug. 17	None.	V. slight.	.05	7.30	.0028	.0044	.94	.0280	.0005	.08	3.6	.0060
17869	Nov. 16	V. slight.	V. slight.	.02	8.60	.0030	.0038	.93	.0470	.0001	.04	[redacted]	.0150

Averages by Years.

-	1887*	-	-	[redacted]	5.82	.0081	.0124	.43	.0123	-	-	-	-
-	1888	-	-	.10	5.81	.0027	.0081	.44	.0308	.0004	-	-	-
-	1889	-	-	.00	6.16	.0031	.0050	.56	.0358	.0002	-	-	-
-	1890	-	-	.00	7.09	.0020	.0039	.65	.0631	.0001	-	3.0	-
-	1891	-	-	.00	6.25	.0023	.0035	.68	.0707	.0001	-	2.8	-
-	1892†	-	-	.13	5.43	.0061	[redacted]	.39	.0225	.0016	-	2.6	.0440
-	1893	-	-	.04	6.07	.0036	.0053	.62	.0460	.0001	.11	2.6	.0099
-	1894	-	-	.03	6.75	[redacted]	.0043	.79	.0515	.0001	.08	2.8	.0272
-	1895	-	-	.04	7.32	.0020	.0049	.92	.0230	.0000	.07	3.0	.0130
-	1896	-	-	.04	7.37	.0022	.0040	.91	.0317	.0002	.04	3.2	.0145

* June to November. † Two samples in October.

NOTE to analyses of 1896: Odor, very faint or none. — The samples were collected from the filter-gallery.

Microscopical Examination.

No. 16565. Fungi, *Crenothrix*, 400.
No. 17214. Miscellaneous, *Zoöglœa*, 5.
No organisms were found in the other samples.

FRAMINGHAM.

Chemical Examination of Water from a Faucet in South Framingham, supplied from the Works of the Framingham Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16072	Feb. 17	Slight.	Slight, rusty.	.03	7.50	.0016	.0036	.84	.0670	.0001	.06	3.0	.0320
16566	May 11	Decided, milky.	Slight, rusty.	.70	7.20	.0016	.0040	.89	.0020	.0000	.06	[illegible]	.2450
17215	Aug. 17	Slight, milky.	V. slight.	.20	7.70	.0000	.0046	.93	.0070	.0005	.05	3.5	.0350
17870	Nov. 16	V. slight	V. slight.	.04	8.10	.0008	.0034	.93	.0300	.0004	.03	3.3	.0200

Averages by Years.

-	1893	-	-	.02	5.96	.0036	.0088	.53	.0297	.0001	.09	2.7	.0272
-	1894	-	-	.03	6.48	.0008	.0082	.73	.0263	.0003	.06	2.9	.0322
-	1895	-	-	.25	6.96	.0006	.0083	.90	.0050	.0000	.06	3.0	.0692
-	1896	-	-	.24	7.62	.0010	.0039	.90	.0240	.0002	.04	3.3	.0830

Note to analyses of 1896: Odor of the first sample, none; of the second, distinctly tarry; of the last two, none, becoming faintly vegetable on heating.

Microscopical Examination.

No. 16072. Fungi, *Crenothrix*, 620; *Molds*, 2. Miscellaneous, *Zoöglœa*, 2. Total, 624.
No. 16566. Fungi, *Crenothrix*, 100.
No organisms were found in the other samples.

FRAMINGHAM.

Chemical Examination of Water from the Underdrain beneath the Sewers at Framingham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1896.												
15891	Jan. 15	Slight.	Slight.	.05	20.90	.0520	.0050	2.16	.3900	.0030	.08	7.7	.0280
16060	Feb. 12	Distinct, milky	Slight.	.06	18.40	.0860	.0050	1.90	.2850	.0017	.06	6.9	.0270
16240	Mar. 11	Slight.	Slight.	.06	21.70	.0448	.0036	1.96	.3300	.0025	.06	6.9	0350
16420	Apr. 15	Slight.	Slight, floc.	.05	19.40	.0162	.0122	2.00	.2650	.0120	.12	7.1	.0220
16596	May 13	Decided.	Cons.	[redacted]	26.60	[redacted]	.1420	2.15	.3800	[redacted]	.28	8.6	.1660
16765	June 10	Decided.	Cons., rusty.	.50	16.20	.0246	.0336	3.15	[redacted]	.0004	.79	5.5	.1300
16993	July 15	Distinct.	Slight.	.10	20.70	.0304	.0080	2.04	.3800	.0045	.14	7.6	.0120
17199	Aug. 13	Slight.	Slight.	.05	21.30	.0280	.0094	2.00	.4000	.0105	.14	8.1	.0200
17419	Sept. 9	Slight.	Slight.	.10	22.30	.0280	.0060	1.82	.2500	.0045	.09	8.0	.0250
17650	Oct. 15	Slight.	Slight.	.04	17.20	.0360	.0070	1.82	.3650	.0060	.11	[redacted]	[redacted]
17840	Nov. 11	None.	V. slight.	.03	16.50	.0006	.0030	[redacted]	.5000	.0000	.05	6.9	.0090
18043	Dec. 9	Distinct.	Slight, brown.	.03	18.50	.0442	.0064	[redacted]	.4250	.0020	.14	7.4	.0100

Averages by Years.

-	1889*	-	-	.00	19.70	.0600	.0060	3.78	.4750	.0045	-	6.6	-
-	1890	-	-	.01	19.71	.0523	.0073	3.51	.5336	.0026	-	6.4	-
-	1891	-	-	.01	20.44	.1029	.0045	3.51	.5353	.0019	-	8.0	-
-	1892	-	-	.01	19.32	.0806	.0042	3.99	.6667	.0018	-	8.0	-
-	1893	-	-	.02	20.75	.0829	.0039	3.54	.6262	.0014	.06	7.4	-
-	1894	-	-	.00	22.24	.0630	.0033	3.61	.5315	.0028	.08	7.1	-
-	1895	-	-	.03	20.92	.0502	.0066	2.29	.4995	.0023	.09	7.7	.0366
-	1896	-	-	.09	19.99	.0463	.0200	2.07	.3575	.0048	.17	7.2	.0419

* October.

Note to analyses of 1896: Odor, frequently mouldy or musty, often none; on heating, somewhat stronger. —— The samples were collected from the underdrain, at its outlet.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows: No. 15891, 296; No. 16060, 1,640; No. 16240, 1,220; No. 16420, 1,844; No. 16596, 4,518; No. 16765, 1,204; No 16993, 104; No. 17199, 90; No. 17419, 113; No. 17650, 4,064; No. 17840, 0; No. 18043, 900. The organisms found consisted chiefly of *Crenothrix*.

FRANKLIN.

WATER SUPPLY OF FRANKLIN. — FRANKLIN WATER COMPANY.

The reply of the State Board of Health to an application from the selectmen of Franklin with reference to the quality of the water supplied by the Franklin Water Company may be found on pages 15–17 of this volume. Analyses of samples of water collected during the investigation made by the Board are given in the following tables: —

Chemical Examination of Water from the Wells of the Franklin Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	[illegible]ness.	Iron.
	1896.												
16186	Mar. 3	None.	None.	.04	11.10	.0000	.0040	1.14	.3000	.0060	.07	4.0	.0030
17221	Aug. 18	None.	V. slight.	.02	6.80	.0002	.0006	0.95	.2000	.0000	.04	3.4	.0050
17345	Sept. 1	None.	V. slight.	.01	9.70	.0002	.0022	0.92	.2250	.0000	.05	3.5	.0050
17222	Aug. 18	None.	V. slight.	.02	[illegible]	.0000	.0012	0.82	.1900	.0000	.07	3.2	.0070
17346	Sept. 1	None.	V. slight.	.01	8.30	[illegible]	.0020	0.82	.2500	.0000	.06	3.1	.0060

Odor, none. A faintly earthy odor was observed in the third and fifth samples when heated. —— The first sample was collected from a tap in the pumping station, while pumping; the next two, from the small well; the last two, from the large well. Water is pumped from the small well, into which water from the large well flows by gravity.

Microscopical Examination.

No organisms.

Chemical Examination of Water from Beaver Pond, Franklin.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. [illegible]	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
17324	Aug. 18	Slight.	Cons.	.90	2.50	1.70	.0004	.0276	.0238	.0038	.30	.0020	.0000	.98	0.6
17347	Sept. 1	Distinct.	Slight.	.75	3.70	1.95	.0002	.0264	.0220	.0044	.28	[illegible]	.0001	.83	0.6

Odor of the first sample, distinctly vegetable and mouldy; of the last, distinctly vegetable. —— The first sample was collected from Beaver Pond, near the southerly shore; the last, from Beaver Pond, near the intake of the Franklin Water Works.

Microscopical Examination.

No. 17324. Diatomaceæ, *Asterionella*, 228; *Ceratoneis*, 2; *Navicula*, 2; *Synedra*, 320. Cyanophyceæ, *Clathrocystis*, 2; *Cœlosphærium*, 6; *Merismopedia*, 16; *Microcystis*, 2. Algæ, *Arthrodesmus*, 8; *Conferva*, 2; *Raphidium*, 6; *Sphærozosma*, 2; *Staurastrum*, 2. Rhizopoda, *Difflugia*, 4. Infusoria, *Ceratium*, 2; *Dinobryon*, 2; *Trachelomonas*, 4. Total, 612.

No. 17347. Diatomaceæ, *Asterionella*, 22; *Cymbella*, 2; *Synedra*, 600. Algæ, *Arthrodesmus*, 4; *Conferva*, 6; *Protococcus*, 10; *Raphidium*, 32. Infusoria, *Ceratium*, 25; *Dinobryon*, 24; *Mallomonas*, 6; *Phacus*, 2; *Trachelomonas*, 4. Miscellaneous, *Zoöglœa*, 5. Total, 729.

FRANKLIN.

Chemical Examination of Water from Mine Brook in Franklin.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
17223	Aug. 18	Slight.	Cons.	.35	4.40	0.90	.0032	.0208	[illegible]	.0080	.45	.0050	.0005	.33	1.8

Odor, distinctly disagreeable. —— The sample was collected from Mine Brook, near the pumping station of the Franklin Water Company. This brook is not used as a source of water supply.

Microscopical Examination.

No. 17223, Diatomaceæ, *Fragilaria*, 3. *Navicula*, 4; *Synedra*, 5. Cyanophyceæ, *Microcystis*, 1. Infusoria, *Peridinium*, 1. Miscellaneous, *Zoöglœa*, 100. Total, 114.

Water Supply of Gardner. — Gardner Water Company.

Chemical Examination of Water from Crystal Lake, Gardner.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	[illegible]														
16081	Feb. 10	V slight.	V. slight.	.10	3.65	1.00	.0016	.0142	.0116	.0026	.34	.0150	.0000	.17	1.3
16568	May 10	Distinct.	Slight.	.06	3.06	1.05	.0032	.0196	.0144	.0052	.36	.0080	.0001	.22	1.1
17151	Aug. 10	Distinct.	Slight.	.05	2.75	0.70	.0004	.0148	.0096	.0052	.28	.0000	.0000	.19	0.8
17835	Nov. 10	V. slight.	V. slight.	.04	2.65	1.00	.0028	.0140	.0124	.0016	.36	.0020	.0001	.16	1.3

Averages by Years.

-	1887*	-	-	[illegible]	2.63	0.62	.0006	.0111	-	-	.21	.0019	-	-	-
-	1888†	-	-	.01	2.60	0.62	.0023	.0112	-	-	.22	.0094	.0001	-	-
-	1891‡	-	-	.02	2.95	0.64	.0007	.0119	.0098	.0021	.16	.0073	.0001	-	0.7
-	1892§	-	-	.02	2.45	0.65	.0008	.0104	.0086	.0018	.27	.0180	.0000	-	1.1
-	1893	-	-	.05	2.66	0.82	.0012	.0126	.0105	.0021	.27	.0021	.0000	.19	0.8
-	1894	-	-	.04	2.75	0.98	.0009	.0111	.0094	.0017	.31	.0023	.0000	.15	1.0
-	[illegible]	-	-	.06	2.76	0.97	.0008	.0192	.0170	.0022	.34	.0020	.0000	.17	1.2
-	1896	-	-	.06	3.07	0.94	.0020	.0156	.0120	.0036	.33	.0050	.0000	.18	1.1

* June to December. † January to May. ‡ June, three samples. § March.

Note to analyses of 1896: Odor, generally vegetable, occasionally also grassy or mouldy. —— The first three samples were collected from faucets in the town; the last, from Crystal Lake.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows: No. 16081, 30; No. 16568, 1,177; No. 17151, 136; No. 17835, 14.

GLOUCESTER.

Water Supply of Gloucester.

Chemical Examination of Water from Dike's Brook Storage Reservoir, Gloucester.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15948	Jan. 25	V. slight.	Slight.	.42	4.25	1.70	.0042	.0150	.0134	.0016	.77	.0050	.0000	.51	0.9
16689	May 28	V. slight.	Slight.	.50	3.65	1 10	.0012	.0124	.0108	.0016	.81	[illegible]	.0001	.25	0.3
17612	Oct. 7	Slight.	Slight.	.25	3.60	1 25	.0042	.0176	.0160	.0016	.90	.0030	.0000	.43	0.3
Av.	....	....	....	.34	3.90	1.35	.0032	.0150	.0134	.0016	.83	.0020	.0000	.40	0.5

Odor, faintly vegetable, becoming stronger on heating.—The samples were collected from the reservoir.

Microscopical Examination.

No. 15948. No organisms.

No. 16689 Diatomaceæ, *Tabellaria*, 27. Algæ, *Pediastrum*, 4; *Protococcus*, 16; *Raphidium*, 10. Miscellaneous, *Zoöglœa*, 40. Total, 96.

No. 17612. Diatomaceæ, *Synedra*, 14. Cyanophyceæ, *Microcystis*, 28. Algæ, *Raphidium*, 16. Vermes, *Polyarthra*, 1; *Rotifer*, 2. Miscellaneous, *Zoöglœa*, 20. Total, 81.

Chemical Examination of Water from Wallace Pond, Gloucester.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15949	Jan. 25	Distinct.	Slight.	.42	5.00	2.10	.0006	.0226	.0182	.0044	1.10	.0000	.0000	.36	0.5
16688	May 28	Slight.	Slight.	.27	3.90	1.20	.0004	.0196	.0132	.0064	1.06	.0000	.0000	.29	0.3
17614	Oct. 7	Slight.	Slight.	.75	5.05	2.00	.0026	[illegible]	.0276	.0072	1.13	.0050	.0000	.77	0.5
Av.	....	....	....	.48	4.65	1.77	.0012	.0257	.0197	.0060	1 10	.0017	.0000	.55	0.4

Odor of the first and last samples, faintly vegetable, becoming stronger on heating; of the second, distinctly vegetable and unpleasant.—The samples were collected from Wallace Pond.

Microscopical Examination.

No. 15949. Diatomaceæ, *Synedra*, 112. Algæ, *Conferva*, 2; *Zoöspores*, 68. Rhizopoda, *Actinophrys*, 8; *Arcella*, 8. Infusoria, *Dinobryon*, 4; *Euglena*, 8; *Mallomonas*, 2; *Peridinium*, 42; *Trachelomonas*, 10. Vermes, *Anuræa*, 1; *Asplanchna*, 1; *Polyarthra*, 1. Crustacea, *Entomostracan ova*, .02. Total, 252.

No. 16688. Diatomaceæ, *Asterionella*, 104; *Navicula*, 2; *Synedra*, 16; *Tabellaria*, 18. Cyanophyceæ, *Microcystis*, 2. Infusoria, *Euglena*, 4; *Glenodinium*, 72; *Monas*, 8; *Peridinium*, 4. Crustacea, *Entomostracan ova*, .02. Miscellaneous, *Zoöglœa*, 80. Total, 310.

No. 17614. Cyanophyceæ, *Microcystis*, 4. Algæ, *Protococcus*, 16; *Scenedesmus*, 4. Infusoria, *Dinobryon*, 2; *Peridinium*, 2; *Trachelomonas*, 12. Vermes, *Rotifer*, 2. Miscellaneous, *Zoöglœa*, 20. Total, 62.

GRAFTON.

WATER SUPPLY OF GRAFTON. — GRAFTON WATER COMPANY.

Chemical Examination of Water from the Filter-gallery of the Grafton Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
17078	July 28	None.	None.	.01	10.40	.0000	.0016	1.10	.1100	.0000	.02	3.8	.0020

Odor, none. —— The sample was collected from a faucet at the pumping station.

Microscopical Examination.

No organisms.

WATER SUPPLY OF GREENFIELD.

Chemical Examination of Water from Faucets in Greenfield supplied from the Greenfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	[redacted]														
16074	Feb. 17	V. slight.	None.	.05	4.65	1.10	.0006	.0046	.0034	.0012	.12	.0180	.0000	.07	2.9
16390	Apr. 13	V. slight.	V. slight.	.02	4.20	0.56	.0000	.0026	.0016	.0010	.14	.0120	.0000	.05	2.5
16745	June 8	None.	None.	.02	5.35	0.75	.0010	.0046	.0036	.0010	.08	.0120	.0000	.13	3.2
17217	Aug. 17	None.	V. slight.	.06	4.90	0.55	.0000	.0082	.0070	.0012	.11	.0070	.0000	.09	3.4
17660	Oct. 19	V. slight.	V. slight.	.04	5.60	0.65	.0004	.0044	.0036	.0008	.12	.0020	.0000	.12	3.2
18122	Dec. 15	None.	V. slight.	.02	5.50	0.65	.0006	.0046	.0034	.0012	.17	.0180	.0000	.06	3.2
Av.				.03	5.02	0.79	.0005	.0048	.0038	.0010	.12	.0115	.0000	.09	3.1

Odor, generally vegetable and earthy. —— The samples were collected from faucets in the village, and represent a mixture of water from Glen Brook Reservoir and Green River.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows: No. 16074, 0; No. 16390, 2; No. 16745, 10; No. 17217, 120; No. 17660, 0; No. 18122, 22.

HARVARD.

Harvard.

The advice of the State Board of Health to Messrs. Hildreth Bros. of Harvard, with reference to a proposed water supply for a factory and a few dwelling-houses in that town, may be found on pages 17 and 18 of this volume.

Chemical Examination of Water from a Tubular Well near the Factory of Hildreth Bros., in Harvard.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16922	July 6	V. slight.	Slight.	.02	11.70	.0002	.0010	.51	.1350	.0030	.06	6.3	.0180
17122	Aug. 4	None.	V. slight.	.01	11.50	.0006	.0006	.51	.1350	.0003	.04	6.6	.0040

Odor, none, becoming distinctly clayey on heating. —— The samples were collected from a tubular well, sunk in rock to a depth of 223 feet. The well is situated on the summit of a hill, near the factory of Hildreth Bros.

Microscopical Examination.

No organisms.

Water Supply of Hatfield.

Population in 1895, 1,262. The works are owned by the town, and were completed in August, 1896. The source of supply is Running Gutter Brook, in the westerly part of the town, on which a small storage reservoir has been constructed. Water is conveyed to the village of Hatfield by gravity through four miles of eight-inch cast-iron pipe. The watershed of the reservoir is largely wooded, and contains no dwelling-houses. The reservoir was prepared for the storage of water by removing all the organic matter from the sides and bottom. Service pipes are of galvanized iron.

The advice of the State Board of Health to the town of Hatfield relative to taking water from Field's Brook to supply that portion of the town known as North Hatfield may be found on page 18 of this volume.

HATFIELD.

Chemical Examination of Water from the Reservoir of the Hatfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
[illegible]	1896. July 9	Slight.	Slight.	.18	4.85	0.90	.0058	.0106	.0082	.0024	.15	[redacted]	.0001	.24	1.0

Odor, distinctly vegetable and unpleasant. —— The sample was collected from the reservoir.

Microscopical Examination.

No organisms.

Chemical Examination of Water from Field's Brook, Hatfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	[redacted]	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
16707	1896. June 1	None.	Slight, sandy.	.01	3.65	0.60	.0000	.0010	.0010	.0000	.11	.0050	.0000	.01	2.1

Odor, none, becoming faintly earthy on heating. —— The sample was collected from Field's Brook, about ½ mile above Pantry Road, near the village of North Hatfield.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

HAVERHILL.

WATER SUPPLY OF HAVERHILL.

Chemical Examination of Water from Crystal Lake, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16141	Feb. 24	None.	V. slight.	.27	3.15	1.10	.0014	.0152	.0132	.0020	.25	.0070	.0000	.37	1.3
16861	June 23	Distinct.	Cons.	.30	3.05	1.45	.0000	.0320	.0152	.0168	.26	.0050	.0000	.42	0.9
17727	Oct. 27	V. slight	Slight.	.13	2.80	1.10	.0006	.0186	.0172	.0014	.31	.0030	.0000	.35	1.2

Averages by Years.

-	1887*	-	-	.14	3.30	0.97	.0011	.0179	-	-	.28	.0022	-	-	-
-	1888†	-	-	.06	3.07	0.98	.0006	.0139	-	-	.22	.0053	.0002	-	-
-	1892‡	-	-	.16	2.87	1.07	.0011	[illegible]	.0156	.0013	.24	.0040	.0000	-	1.0
-	1893	-	-	.26	2.73	1.12	.0008	.0182	.0150	.0032	.24	.0020	.0000	.37	1.0
-	1894	-	-	.17	3.05	1.08	.0017	.0220	.0193	.0027	.27	.0007	.0000	.34	1.0
-	1895	-	-	.11	3.32	1.22	.0012	.0180	.0159	.0021	.30	.0015	.0000	.36	1.5
-	1896	-	-	.23	3.00	1.22	.0007	.0219	.0152	.0067	.27	.0050	.0000	.38	1.1

* June to November. † January, March and May. ‡ July, two samples.

NOTE to analyses of 1896: Odor, faintly vegetable. —— The samples were collected from a faucet at the office of the Haverhill water works. For monthly height of water in this lake, see table on pages 168 and 169.

Microscopical Examination.

No. 16141. Diatomaceæ, *Asterionella*, 9. Infusoria, *Dinobryon*, 6. Total, 15.

No. 16861. Diatomaceæ, *Synedra*, 4; *Tabellaria*, 27. Algæ, *Protococcus*, 9. Fungi, *Crenothrix*, 20. Infusoria, *Peridinium*, 1. Vermes, *Anuræa*, 1. Miscellaneous, *Zoöglœa*, 200. Total, 262.

No. 17727. Diatomaceæ, *Asterionella*, 14; *Synedra*, 8. Infusoria, *Dinobryon*, 1. Total, 23.

HAVERHILL.

Chemical Examination of Water from Kenoza Lake, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15973	Jan. 28	Distinct.	Slight.	.07	4.00	1.50	.0016	.0136	.0122	.0014	.39	.0000	.0000	.25	1.9
16140	Feb. 24	Slight, milky.	V. slight.	.10	4.15	1.20	.0018	.0174	.0150	.0024	.40	.0050	.0000	.21	1.4
16315	Mar. 24	Distinct, clayey.	Slight.	.07	3.10	0.70	.0026	.0156	.0142	.0014	.43	.0070	.0000	.25	1.6
16679	May 26	V. slight.	V. slight.	.15	3.60	1.35	.0000	.0152	.0138	.0014	.44	.0030	.0000	.25	1.8
16856	June 23	None.	V. slight.	.12	3.75	1.30	.0000	.0146	.0120	.0026	.36	.0020	.0000	.26	1.6
17072	July 28	V. slight.	V. slight.	.10	3.95	1.40	.0022	.0170	.0146	.0024	.36	.0020	.0000	.23	1.7
17275	Aug 24	V. slight.	V. slight.	.10	3.95	1.25	.0000	.0168	.0154	.0014	.36	.0020	.0000	.25	1.7
17544	Sept. 23	V. slight.	Slight.	.07	4.00	1.30	[illegible]	.0206	.0176	.0030	.44	.0020	.0000	.24	1.6
17728	Oct. 27	V. slight.	Slight, white.	.09	3.55	0.70	.0028	.0168	.0158	.0010	.40	.0000	.0000	.23	1.9
17963	Nov. 24	V. slight.	Slight.	.09	4.25	1.00	.0006	.0138	.0108	.0030	.43	.0000	.0000	.23	1.8
18304	Dec. 28	Distinct.	Slight.	.13	3.96	1.30	.0002	.0164	.0144	.0020	.39	.0000	.0000	.22	1.9

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Free Ammonia.	Albuminoid Total.	Albuminoid Dissolved.	Albuminoid Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1887*	-	-	.02	3.52	0.71	.0009	.0145	-	-	.34	.0017	-	-	-
-	1888	-	-	.01	3.47	0.81	.0003	.0148	-	-	.34	.0060	.0000	-	-
-	1889†	-	-	.04	3.60	0.90	.0005	.0126	-	-	.34	.0051	.0001	-	-
-	1893	-	-	.09	3.65	1.12	.0013	.0202	.0163	[illegible]	.41	.0010	.0000	.26	1.6
-	1894	-	-	.06	3.40	0.79	.0015	.0148	.0132	.0016	.40	.0027	.0000	.22	1.6
-	1895	-	-	.09	3.97	1.17	.0005	.0177	.0165	.0012	.44	.0000	.0000	.25	2.0
-	1896	-	-	.10	3.86	1.19	.0011	.0162	.0142	.0020	.39	.0021	.0000	.24	1.6

* June to November. † January to June.

Note to analyses of 1896: Odor, vegetable, occasionally none. —— No. 16856 was collected from the lake; the others, from a faucet at the pumping station. During the year 1896 144,000,000 gallons of water were pumped from the Millvale Reservoir on East Meadow Brook into Kenoza Lake. For monthly height of water in this lake, see table on pages 168 and 169.

HAVERHILL.

Microscopical Examination of Water from Kenoza Lake, Haverhill.

[Number of organisms per cubic centimeter.]

	1896.										
	Jan.	Feb	Mar	May.	June.	July	Aug.	Sept.	Oct.	Nov	Dec.
Day of examination,	30	26	25	27	24	30	25	24	23	25	30
Number of sample,	15973	16140	16315	16679	16856	17072	17275	17544	17728	17952	18204
PLANTS.											
Diatomaceæ,	1,512	289	103	192	33	2	2	104	64	295	790
Asterionella,	1,440	280	86	5	0	0	0	74	34	164	632
Cyclotella,	0	9	16	176	11	0	0	0	5	0	0
Fragilaria,	0	0	0	0	19	0	0	0	7	3	0
Melosira,	0	0	0	0	0	2	0	0	20	0	0
Navicula,	0	0	0	0	0	0	0	4	2	2	0
Stephanodiscus,	68	0	0	0	0	0	0	0	0	26	22
Synedra,	0	0	0	1	3	0	1	12	9	0	0
Tabellaria,	4	0	0	10	[illegible]	0	1	14	7	96	136
Cyanophyceæ,	0	0	0	0	25	8	0	38	0	0	0
Anabæna,	0	0	0	0	17	1	0	[illegible]	0	0	0
Microcystis,	0	0	0	0	8	7	0	[illegible]	0	0	0
Algæ,	0	0	0	11	87	44	13	24	0	10	0
Cœlastrum,	0	0	0	0	8	0	0	0	0	0	0
Protococcus,	0	0	0	0	49	6	1	20	0	10	0
Raphidium,	0	0	0	11	0	38	0	4	0	0	0
Staurogenia,	0	0	0	0	0	0	12	0	0	0	0
ANIMALS.											
Infusoria,	1	6	0	1	132	0	0	[illegible]	1	4	2
Dinobryon,	0	0	0	1	132	0	0	0	1	0	0
Dinobryon cases,	0	0	0	0	0	0	0	10	0	0	0
Peridinium,	1	6	0	0	0	0	0	0	0	2	2
Tintinnidium,	0	0	0	0	0	0	0	0	0	2	0
Miscellaneous, Zoöglœa,	0	0	2	5	0	0	20	0	0	10	8
TOTAL,	1,513	295	103	209	247	54	35	176	65	320	800

HAVERHILL.

Chemical Examination of Water from Lake Saltonstall, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16136	Feb. 24	Slight, clayey.	V. slight.	.19	5.10	1.35	.0036	.0134	.0114	.0020	.64	.0140	.0000	.22	1.9
16858	June 23	None.	V. slight.	.12	5.55	0.90	.0010	.0144	.0120	.0024	.74	.0080	.0000	.21	2.5
17731	Oct. 27	V. slight.	Slight.	.06	5.65	1.40	.0014	.0168	.0134	.0034	.76	.0000	.0001	.17	2.5

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1887*	-	-	.05	4.40	0.75	.0010	.0155	-	-	.58	.0023	-	-	-
-	1888†	-	-	.07	4.72	0.82	.0026	.0125	-	-	.60	.0093	.0003	-	-
-	1892‡	-	-	.01	5.35	1.25	.0000	.0183	.0147	.0036	.64	.0010	.0000	-	2.2
-	[illegible]	-	-	.09	5.10	[illegible]	.0051	.0205	.0178	.0027	.59	.0030	.0000	.25	2.2
-	1894	-	-	.08	5.00	[illegible]	[illegible]	.0155	.0139	.0017	.67	.0023	.0000	.17	2.1
-	[illegible]	-	-	.07	5.95	1.50	.0034	.0180	.0158	.0022	.77	.0015	.0000	.21	2.6
-	1896	-	-	.10	5.43	1.22	.0020	.0149	.0123	.0026	.71	.0057	.0000	.20	2.3

* June to November. † January, March and May. ‡ June and July.

NOTE to analyses of 1896: Odor, vegetable and mouldy. —— The samples were collected from the lake. For monthly height of water in this lake, see table on pages 168 and 169.

Microscopical Examination.

No. 16136. No organisms.

No. 16858. Diatomaceæ, *Asterionella*, 4; *Cyclotella*, 16; *Synedra*, 6; *Tabellaria*, 4; *Triceratium*, 2. Algæ, *Cœlastrum*, 15; *Protococcus*, 32; *Raphidium*, 1; *Scenedesmus*, 1; *Staurogenia*, 5. Infusoria, *Dinobryon*, 15. Miscellaneous, *Zoöglœa*, 5. Total, 106.

No. 17731. Diatomaceæ, *Asterionella*, 212; *Melosira*, 22; *Synedra*, 3. Algæ, *Protococcus*, 7; *Raphidium*, 6; *Scenedesmus*, 2; *Staurogenia*, 1. Infusoria, *Peridinium*, 1; *Trachelomonas*, 1. Miscellaneous, *Zoöglœa*, 10. Total, 265.

HAVERHILL.

Chemical Examination of Water from Lake Pentucket, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16137	Feb 24	Slight.	Slight.	.10	4.46	1.46	.0024	.0192	.0170	.0022	.46	.0080	.0000	.27	1.7
16857	June 23	V. slight.	V. slight.	.12	4.00	1.10	.0000	.0206	.0204	.0002	.44	.0020	.0000	.30	1.6
17732	Oct. 27	None.	V. slight.	.06	3.70	1.35	.0002	.0176	.0168	.0008	.46	.0080	.0000	.23	1.9

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1887*	-	-	.08	3.44	0.67	.0006	.0172	-	-	.37	.0023	-	-	-
-	1888†	-	-	.00	3.37	1.00	.0005	.0149	-	-	.39	.0073	.0001	-	-
-	1892‡	-	-	.02	3.90	1.20	.0002	.0168	.0145	.0023	.36	.0035	.0000	-	1.6
-	1893	-	-	.07	3.43	1.07	.0009	.0199	.0160	.0039	.37	.0000	.0000	[illegible]	1.5
-	1894	-	-	.10	3.97	1.20	.0011	.0184	.0167	.0017	.42	.0000	.0000	.24	1.6
-	1895	-	-	.05	4.30	1.20	.0005	.0198	.0183	.0015	.49	.0016	.0000	.24	2.0
-	1896	-	-	.09	4.05	1.30	.0009	.0191	.0181	.0010	.46	.0027	.0000	27	1.7

* June to November. † January to May. ‡ June and July.

NOTE to analyses of 1896: Odor, faintly vegetable. —— The samples were collected from the lake. For monthly height of water in this lake, see table on pages 168 and 169.

Microscopical Examination.

No. 16137. Diatomaceæ, *Tabellaria*, 2. Infusoria, *Dinobryon*, 1. Total, 3.

No. 16857. Diatomaceæ, *Asterionella*, 3; *Synedra*, 1. Cyanophyceæ, *Microcystis*, 3. Algæ, *Cœlastrum*, 20; *Protococcus*, 220; *Raphidium*, 2; *Staurogenia*, 4. Infusoria, *Dinobryon*, 116; *Mallomonas*, 1; *Peridinium*, 2. Vermes, *Rotifer*, 11. Miscellaneous, *Acarina*, .04; *Zoöglœa*, 5. Total, 388.

No. 17732. Diatomaceæ, *Melosira*, 7; *Synedra*, 4. Algæ, *Raphidium*, 6. Infusoria, *Dinobryon*, 1. Total, 18.

HAVERHILL.

Chemical Examination of Water from East Meadow River at its Entrance into Millvale Reservoir, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15971	Jan 28	Slight.	Slight.	1.00	5.20	2.45	.0012	.0186	.0164	.0022	.30	.0120	.0000	0.90	1.8
16135	Feb 24	V slight	V slight.	0.45	5.30	1.85	.0008	.0108	.0098	.0010	.30	.0100	.0001	0.46	1.6
16313	Mar. 24	Slight.	Slight.	0.70	4.00	1.60	.0006	.0160	.0140	.0020	.32	.0060	.0000	0.70	1.3
16459	Apr. 28	Distinct.	Slight.	0.80	4.45	1.70	.0010	.0216	.0190	.0026	.22	.0000	.0001	0.69	1.3
16650	May 26	Slight.	Slight.	1.10	5.20	2.30	.0002	.0258	.0232	.0026	.25	.0050	.0000	0.93	-
16859	June 23	Slight.	V slight.	0.52	5.00	1.60	.0000	.0158	.0140	.0018	.26	.0000	.0000	0.33	1.9
17073	July 28	Slight, milky.	Slight.	0.55	5.60	1.70	.0004	.0170	.0150	.0020	.28	.0020	.0000	0.49	2.0
17276	Aug. 24	Distinct.	Slight.	0.50	5.20	1.70	.0004	.0150	.0130	.0020	.24	.0000	.0001	0.48	2.1
17545	Sept 22	V slight.	Slight.	1.00	7.20	3.10	.0040	.0334	.0300	.0034	.37	.0030	.0001	1.16	2.1
17729	Oct 27	V. slight.	Slight.	1.10	7.00	3.20	.0030	.0300	.0278	.0022	.46	.0060	.0000	1.31	2.5
17950	Nov 24	V. slight.	Slight.	[illegible]	6.45	2.50	.0016	.0250	.0192	.0058	.44	.0050	.0001	0.96	2.1
18205	Dec. 28	None.	Slight.	0.60	5.70	1.65	.0006	.0124	.0112	.0012	.39	.0110	.0000	0.66	2.2
Av.	1896	....	....	0.77	5.52	2.13	.0012	.0201	.0177	.0024	.32	.0049	.0000	0.80	1.9
Av.	1895*	....	....	0.75	4.72	1.85	.0000	.0155	.0143	.0012	.30	.0035	.0000	0.66	2.2

* April and July.

NOTE to analyses of 1896: Odor, distinctly vegetable, frequently also mouldy. —— The samples were collected from the river at Thompson's bridge, just above its entrance into the Millvale storage reservoir.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 60.

Chemical Examination of Water from Millvale Reservoir on East Meadow River, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15972	Jan. 28	Slight.	Slight.	0.66	4.35	1.90	.0022	.0156	.0146	.0010	.28	.0050	.0000	0.66	1.6
16136	Feb. 24	V. slight.	V. slight.	0.90	5.15	1.80	.0012	.0192	.0160	.0032	.30	.0080	.0000	0.69	1.3
16314	Mar 24	Slight.	Slight.	0.55	3.25	1.25	.0006	.0160	.0134	.0026	.26	.0070	.0000	0.64	1.6
16460	Apr 28	Slight.	Slight.	1.10	5.10	1.95	.0024	.0230	.0214	.0016	.25	.0070	.0002	0.87	1.7
16651	May 26	Slight.	Slight.	0.75	4.70	1.95	.0000	.0210	.0188	.0022	.30	.0090	.0000	0.66	1.7
16860	June 23	V. slight.	V. slight	0.75	5.40	2.30	.0000	.0208	.0192	.0016	.32	.0000	.0000	0.76	1.8
17074	July 28	Slight	Slight	0.42	5.00	1.90	.0004	.0212	.0198	.0014	.33	.0020	.0000	0.40	1.9
17277	Aug 24	V slight.	V slight.	0.40	4.65	1.65	.0000	.0204	.0182	.0022	.28	.0000	.0000	0.64	1.9
17546	Sept 22	V. slight	Slight.	0.70	5.65	2.55	.0004	.0304	.0290	.0014	.32	.0000	.0001	0.94	1.8
17730	Oct 27	V. slight.	Slight.	0.70	5.90	2.55	.0030	.0268	.0252	.0016	.37	.0030	.0000	0.94	2.1
17951	Nov 24	V. slight.	Slight.	0.90	6.45	2.50	.0010	.0290	.0274	.0016	.42	.0020	.0000	0.97	2.1
18206	Dec 28	None.	Slight.	1.05	6.25	2.60	.0004	.0238	.0212	.0026	.43	.0100	.0000	1.05	2.5
Av.	....	....	....	0.74	5.15	2.09	.0010	.0223	.0204	.0019	.32	.0044	.0000	0.76	1.8

Odor, generally faintly vegetable, becoming somewhat stronger on heating. —— The samples were collected from the reservoir, near its outlet.

HAVERHILL.

Microscopical Examination of Water from Millvale Reservoir on East Meadow River, Haverhill.

[Number of organisms per cubic centimeter.]

	[illegible]											
	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.
Day of examination,	30	26	25	30	27	24	30	25	24	28	25	30
Number of sample,	15972	16139	16314	16490	16678	16860	17074	17277	17546	17730	17951	18206
PLANTS.												
Diatomaceæ,	0	0	0	26	[illegible]	30	42	0	34	90	30	20
Cyclotella,	0	0	0	0	0	30	0	0	2	6	10	0
Diatoma,	0	0	0	0	0	0	0	0	8	0	0	0
Synedra,	0	0	0	26	5	0	42	0	24	84	20	20
Cyanophyceæ, Merismopedia,	0	0	0	0	0	[illegible]	0	0	[illegible]	0	0	0
Algæ,	[illegible]	0	0	0	[illegible]	46	2	1	0	0	0	0
Cosmarium,	0	0	0	0	0	14	0	0	0	0	0	0
Protococcus,	0	0	0	0	0	32	2	[illegible]	0	0	0	0
ANIMALS.												
Infusoria,	2	21	10	15	2	28	1	0	28	1	0	2
Dinobryon,	0	17	0	0	0	26	1	0	0	1	0	0
Dinobryon cases,	0	0	0	15	0	0	0	0	26	0	0	0
Euglena,	0	2	0	0	0	0	0	0	0	0	0	0
Mallomonas,	0	0	0	0	0	2	0	[illegible]	0	0	0	0
Peridinium,	2	0	10	0	0	0	0	0	2	0	0	2
Synura,	0	2	0	0	0	0	0	0	0	0	0	0
Uroglena,	0	0	0	0	[illegible]	0	0	0	[illegible]	0	0	0
Crustacea, Cyclops,	0	0	0	0	[illegible]	0	0	0	.04	.04	0	0
Miscellaneous,	10	0	0	0	20	[illegible]	40	20	20	[illegible]	5	5
Acarina,	0	0	0	0	0	.02	0	0	0	0	0	0
Zoöglœa,	10	0	0	0	20	5	40	20	20	5	5	5
TOTAL,	12	22	10	41	31	109	85	21	90	96	35	27

Table showing the Heights of Water in the Lakes of the Haverhill Water Works on the First of Each Month in 1896.

DATE.	Crystal Lake. High Water, 8.00 Feet.	Kenoza Lake. High Water, 4.00 Feet.	Lake Saltonstall. High Water, 7.88 Feet.	Lake Pentucket. High Water, 6.67 Feet.
Jan. 1,	3.75	0.71	3.00	3.71
Feb. 1,	4.33	0.71	4.00	4.71
March 1,	5.79	2.12	5.54	5.42
April 1,	8.83	3.12	6.25	6.33

HAVERHILL.

Table showing the Heights of Water in the Lakes of the Haverhill Water Works on the First of Each Month in 1896 — Concluded.

DATE.	Crystal Lake. High Water, 8.00 Feet.	Kenoza Lake. High Water, 4.00 Feet.	Lake Saltonstall. High Water, 7.33 Feet.	Lake Pentucket. High Water, 6.67 Feet.
May 1,	8.12	3.68	6.25	6.12
June 1,	7.16	3.71	6.82	4.87
July 1,	6.21	3.62	6.42	4.33
Aug. 1,	5.00	3.17	6.43	4.33
Sept. 1,	4.50	2.71	6.42	3.92
Oct. 1,	4.33	2.79	6.00	4.00
Nov. 1,	4.42	3.17	7.04	3.92
Dec. 1,	4.75	3.25	7.00	4.16

The advice of the State Board of Health to the Haverhill Real Estate Improvement Company, with reference to the use of water from a well situated under a building owned by the company, may be found on pages 18 and 19 of this volume. Analyses of samples of water taken from the well at different times are given in the following table: —

Chemical Examination of Water from the Well of the Real Estate Improvement Company, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16671	May 25	Distinct.	Slight.	.30	3.00	.0004	.0150	0.23	.0030	.0000	.41	1.3	–
16891	June 25	Distinct.	Slight, earthy.	.20	24.30	.0066	.0098	1.60	.5250	.0060	.22	12.5	.0550
17265	Aug. 21	None.	V. slight.	.02	30.30	.0000	.0082	2.10	.6250	.0000	.05	18.0	.0000

Odor of the first sample, faintly vegetable; of the second, faintly vegetable, becoming distinctly vegetable and mouldy on heating; of the third, none, becoming distinctly mouldy on heating.—— The first sample was collected from a faucet in the building owned by the Real Estate Improvement Company in Haverhill, and probably represents water from the Haverhill water works; the second sample was collected from a blow-off valve beneath the building, and probably represents water from a well beneath the building, driven through rock to a depth of 226 feet, mixed with water from the city water works; the third sample was collected from the blow-off valve beneath the building after a considerable quantity had been pumped from the well into the pipes, and probably represents chiefly water from the well.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows: No. 16671, 204; No. 16891, 8; No. 17265, 9.

HINGHAM AND HULL.

WATER SUPPLY OF HINGHAM AND HULL. — HINGHAM WATER COMPANY.

Chemical Examination of Water from Accord Pond, Hingham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16083	Feb. 10	V. slight.	Slight.	.38	3.30	1.40	.0004	.0126	.0118	.0008	.60	.0030	.0001	.42	0.5
16778	June 12	Distinct.	Slight.	.38	2.65	1.20	.0002	.0166	.0148	.0018	.60	.0000	.0000	.45	0.1
17633	Oct. 13	Slight.	Cons.	.10	2.90	1.05	.0014	.0158	.0130	.0028	.67	.0050	.0000	.20	0.3

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Free Ammonia.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1887*	-	-	.19	3.38	1.08	.0006	.0133	-	-	.55	.0043	-	-	-
-	1888	-	-	.29	2.98	0.97	.0001	.0162	-	-	.56	.0046	.0001	-	-
-	1889†	-	-	.32	3.13	1.01	.0002	.0126	.0108	.0018	.55	.0040	.0002	-	-
-	1892‡	-	-	.25	2.95	0.96	[redacted]	.0114	.0100	.0014	.64	.0040	.0000	-	0.2
-	1893	-	-	.16	3.09	1.00	.0008	.0121	.0103	.0018	.68	.0032	.0000	.29	0.3
-	1894	-	-	.20	3.04	1.11	.0002	.0114	.0097	.0017	.62	[redacted]	.0000	.33	0.2
-	1895	-	-	.22	3.50	1.37	.0008	.0135	.0121	.0014	.67	.0110	[redacted]	.31	[redacted]
-	1896	-	-	.22	3.02	1.22	.0007	.0150	.0132	.0018	.62	.0027	.0000	.37	0.3

* June to December. † January to June. ‡ March.

NOTE to analyses of 1896: Odor of the first two samples, vegetable; of the third, none, becoming faintly vegetable on heating. —— The samples were collected from the pond.

Microscopical Examination.

No. 16083. Diatomaceæ, *Asterionella*, 32; *Synedra*, 6; *Tabellaria*, 6. Infusoria, *Dinobryon*, 1. Vermes, *Anurea*, 1. Miscellaneous, *Sponge Spicules*, 1. Total, 46.

No. 16778. Diatomaceæ, *Asterionella*, 4; *Melosira*, 10; *Navicula*, 1; *Stephanodiscus*, 30; *Synedra*, 1; *Tabellaria*, 6. Rhizopoda, *Actinophrys*, 1. Infusoria, *Dinobryon*, 224; *Euglena*, 1; *Mallomonas*, 1; *Peridinium*, 3. Vermes, *Rotatorian ova*, 2. Miscellaneous, *Sponge Spicules*, 1; *Zoöglœa*, 20. Total, [redacted]

No. 17633. Infusoria, *Melosira*, 46; *Navicula*, 2; *Pinnularia*, 2; *Stephanodiscus*, 2; *Synedra*, 10. Cyanophyceæ, *Merismopedia*, 20; *Microcystis*, 10. Algæ, *Protococcus*, 2. Miscellaneous, *Zoöglœa*, 30. Total, 126.

HINGHAM AND HULL.

Chemical Examination of Water from Fulling Mill Pond, Hingham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16034	Feb. 10	V. slight.	Slight.	.70	4.95	1.60	.0000	.0090	.0076	.0014	.55	.0180	.0001	.51	1.1
16779	June 12	V. slight.	Slight.	.53	5.10	1.70	.0000	.0098	.0078	.0020	.58	.0190	.0001	.57	1.4
17632	Oct. 12	Slight.	Cons.	.08	4.80	1.00	.0004	.0098	.0076	.0022	.70	.0160	.0000	.18	1.3

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1887*	-	-	.57	5.80	1.27	.0059	.0206	-	-	.67	.0070	-	-	-
-	1888	-	-	.85	5.19	1.47	.0005	.0537	-	-	.68	.0067	.0002	-	-
-	1889†	-	-	.15	-	-	.0002	.0246	.0152	.0094	.78	.0080	.0000	-	-
-	1893	-	-	.23	4.50	1.33	.0006	.0223	.0118	.0105	.67	.0078	.0001	.32	1.2
-	1894	-	-	.22	4.67	1.12	.0110	.0212	.0082	.0130	.64	.0162	.0000	.21	1.3
-	1895	-	-	.18	4.67	1.27	.0011	.0107	.0078	.0029	.72	.0167	.0000	.25	1.3
-	1896	-	-	.44	4.95	1.43	.0001	.0095	.0077	.0018	.62	.0173	.0001	.40	1.3

* June to October. † September.

Note to analyses of 1896: Odor of the first two samples, vegetable; of the last, none, becoming very faintly vegetable on heating. — The samples were collected from the pond.

Microscopical Examination.

An insignificant number of organisms was found in each of these samples.

Water Supply of Hinsdale Fire District. — Hinsdale.

Chemical Examination of Water from the Storage Reservoir of the Hinsdale Fire District.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
15974	Jan. 28	Distinct.	Slight.	.32	2.70	1.85	.0006	.0204	.0146	.0058	.06	.0000	.0000	.43	0.6
16164	Feb. 28	Slight.	Slight.	.35	3.05	1.35	.0092	.0186	.0166	.0020	.05	.0020	.0000	.40	0.5
16325	Mar 25	Slight.	Slight.	.22	2.80	0.80	.0000	.0236	.0128	.0108	.07	.0070	.0000	.47	2.1
16446	Apr. 21	Distinct.	Cons., yellow.	.23	2.05	0.60	.0000	.0100	.0088	.0012	.04	.0070	.0000	.32	0.3
16672	May 24	Distinct, yellow.	Slight.	.25	2.20	1.00	.0004	.0170	.0136	.0034	.07	.0020	.0000	.30	0.7
16853	June 22	Distinct.	Cons.	.40	3.35	1.65	.0000	.0256	.0142	.0114	.05	.0030	.0000	.43	0.5
17022	July 20	Distinct	Slight.	.33	3.60	2.00	.0008	.0228	.0148	.0080	.06	.0030	.0000	.53	1.5
17302	Aug. 26	V. slight.	Slight.	.40	2.90	1.35	.0006	.0202	.0184	.0018	.04	.0000	.0001	.46	1.4
17536	Sept. 21	V. slight, milky.	V. slight.	.43	2.60	0.95	.0094	.0208	.0180	.0028	.04	.0050	.0004	.45	1.2
17745	Oct. 28	Slight.	Slight.	.37	2.55	1.05	.0000	.0144	.0128	.0016	.06	.0000	.0000	.40	1.1
17958	Nov. 24	Slight.	Slight.	.38	2.85	1.15	.0000	.0150	.0150	.0024	.08	.0020	.0000	.42	0.7
18171	Dec. 21	Distinct, green.	Slight, green.	.30	2.20	1.00	.0006	.0226	.0172	.0054	.06	.0000	.0000	.38	0.8

HINSDALE.

Chemical Examination of Water from the Storage Reservoir of the Hinsdale Fire District — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
-	1890*	-	-	.08	1.90	0.75	.0000	.0106	.0084	.0022	.05	.0030	.0000	-	1.1
-	1891†	-	-	.75	3.00	1.57	.0112	.0263	.0208	.0050	.06	.0100	.0001	-	0.6
-	1893‡	-	-	.20	2.53	1.38	.0002	.0218	.0135	.0083	.04	.0010	.0000	.46	0.3
-	1894§	-	-	.30	3.06	1.77	.0001	.0257	.0142	.0115	.08	.0009	.0001	.50	0.6
-	1895	-	-	.35	3.27	1.72	.0002	.0271	.0165	.0106	.06	.0012	.0000	.52	0.5
-	1896	-	-	.33	2.70	1.19	.0016	.0195	.0148	.0047	.06	.0026	.0000	.42	0.9

* March. † June and October. ‡ May, August and November. § May to December.

Note to analyses of 1896: Odor, distinctly vegetable and sweetish. —— The samples were collected from a faucet in the village.

Microscopical Examination of Water from the Storage Reservoir of the Hinsdale Fire District.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Mar.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	30	2	26	22	27	23	21	27	23	29	27	23
Number of sample,	15874	16164	16325	16446	16672	16853	[illegible]	17302	17536	17745	17958	18171
PLANTS.												
Diatomaceæ,	0	0	0	0	0	8	0	0	136	224	6	0
Synedra,	0	0	0	0	[illegible]	0	0	0	136	224	3	0
Tabellaria,	0	0	0	0	[illegible]	8	0	0	0	0	3	0
Algæ, Palmella,	10,400	800	560	2,000	1,600	160	26,000	1,000	214	0	5	0
ANIMALS.												
Infusoria,	76	0	0	0	116	40	0	27	5	5	19	23
Dinobryon,	0	0	0	0	116	40	0	24	0	3	1	0
Peridinium,	76	0	0	0	0	0	0	3	1	2	18	23
Trachelomonas,	0	0	0	0	0	0	0	0	4	0	0	0
Vermes,	1	1	0	0	2	0	0	7	0	2	5	1
Anuræa,	0	1	0	0	2	0	0	2	0	2	2	1
Polyarthra,	0	0	0	0	0	0	0	0	0	0	2	0
Rotifer,	1	0	0	0	0	0	0	5	0	0	1	0
Crustacea, Cyclops,	0	0	0	0	0	0	0	.02	0	0	0	0
Miscellaneous, Zoöglœa,	0	0	0	0	0	60	0	0	25	5	0	10
Total,	10,477	801	560	2,000	1,718	268	26,000	1,034	380	237	35	34

WATER SUPPLY OF HOLLISTON. — HOLLISTON WATER COMPANY.

Chemical Examination of Water from the Works of the Holliston Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1896.												
15686	Jan. 15	None.	None.	.25	3.60	.0004	.0076	.28	[redacted]	.0000	.28	1.3	[redacted]
16225	Mar. 10	V. slight.	V. slight.	[redacted]	2.95	.0004	.0124	.33	.0060	.0000	.28	0.8	–
16577	May 11	V. slight.	Slight.	.40	3.15	.0002	.0170	.26	.0050	.0000	.43	0.8	–
16973	July 14	V. slight.	V. slight.	.20	4.00	.0000	.0072	.28	.0030	.0000	.24	0.6	.0150
17386	Sept. 8	None.	None.	.17	4.20	.0000	.0096	.28	.0070	[redacted]	.15	1.4	.0090
17790	Nov. 9	V. slight.	Slight.	.40	4.20	.0006	.0144	.85	.0000	.0001	.46	1.2	–

Averages by Years.

–	1891*	–	–	.00	5.70	.0000	.0021	.24	.0110	.0000	–	1.8	–
–	1892	–	–	.05	4.16	.0001	.0043	.27	.0106	.0000	–	2.1	.0430
–	1894	–	–	.10	4.60	.0001	.0065	.32	.0135	.0001	.05	2.4	.0215
–	1895	–	–	.25	4.28	.0006	.0097	.31	.0117	.0000	.29	1.6	.0095
–	1896	–	–	.28	3.68	.0003	.0114	.38	.0052	.0000	.30	1.0	.0087

* August, two samples.

NOTE to analyses of 1896: Odor in July and September, none; at other times, vegetable. —— The first four samples were collected from a faucet at the pumping station, while pumping; the last two were collected from faucets in the town.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

HOLYOKE.

Water Supply of Holyoke.

Chemical Examination of Water from Whiting Street Storage Reservoir, Holyoke.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
15963	Jan. 27	Slight.	Slight.	.25	5.10	1.40	.0200	.0158	.0132	.0026	.16	.0060	.0000	.29	2.4
16322	Mar. 25	Distinct.	Cons.	.32	5.65	1.10	.0128	.0166	.0106	.0060	.17	.0100	.0002	.27	4.0
16663	May 25	Distinct, white.	Cons.	.20	4.40	1.25	.0006	.0194	.0130	.0064	.15	.0050	.0001	.14	2.6
17059	July 27	Decided.	Cons.	.20	5.45	1.70	.0000	.0320	.0204	.0116	.13	.0030	.0000	.34	2.7
17554	Sept. 24	Distinct, green	Cons., green	.25	5.65	1.90	.0024	.0396	.0294	.0102	.14	.0000	.0000	.37	2.3
17949	Nov. 24	Distinct.	Slight.	.15	4.55	1.30	.0012	.0254	.0158	.0096	.16	.0050	.0000	.30	2.6

Averages by Years.

From Brook before Reservoir was built.

-	1887*	-	-	.48	7.89	[illegible]	.0024	.0304	-	-	.13	.0126	-	-	-
-	1888	-	-	.25	6.63	1.22	.0009	.0183	-	-	.10	.0061	.0001	-	-
-	1889†	-	-	.14	6.72	[illegible]	[illegible]	.0134	.0092	.0042	.11	.0064	.0001	-	-

From Reservoir.

-	1890‡	-	-	.30	6.05	1.60	.0008	.0244	.0188	.0056	.15	.0120	.0000	-	3.6
-	1891	-	-	.41	6.34	2.05	.0125	.0311	.0253	.0058	12	.0188	.0006	-	3.1
-	1892	-	-	.30	5.57	1.36	.0029	.0294	.0247	.0047	14	.0192	.0001	-	2.5
-	1893	-	-	.18	4.67	1.53	.0008	.0251	.0183	.0068	18	.0063	.0001	.38	2.5
-	1894	-	-	.27	5.08	1.29	.0007	.0204	.0155	.0049	.16	.0067	.0000	.33	2.9
-	1895	-	-	.33	5.62	1.70	.0056	.0311	.0206	.0106	16	.0045	.0001	.35	3.1
-	1896	-	-	.23	5.20	1.44	.0061	.0255	.0176	.0079	.15	.0048	.0000	.28	2.6

* June to December. † January to May. ‡ December.

Note to analyses of 1896: Odor, generally faintly vegetable, becoming somewhat stronger on heating. —— The samples were collected from the reservoir.

HOLYOKE.

Microscopical Examination of Water from Whiting Street Storage Reservoir, Holyoke.

[Number of organisms per cubic centimeter.]

	1896.					
	Jan.	Mar.	May.	July.	Sept.	Nov.
Day of examination,	28	26	26	28	25	25
Number of sample,	15968	16822	16663	17059	17554	17949
PLANTS.						
Diatomaceæ,	**170**	**93**	**330**	**34**	**252**	**228**
Asterionella,	4	88	232	3	30	112
Fragilaria,	0	0	76	0	0	76
Meridion,	0	0	0	0	0	4
Navicula,	0	0	0	0	2	4
Synedra,	166	5	22	31	220	24
Triceratium,	0	0	0	0	0	8
Cyanophyceæ,	**0**	**0**	**0**	**9**	**100**	**20**
Anabæna,	0	0	0	1	60	0
Cœlosphærium,	0	0	0	8	40	20
Algæ,	**14**	**71**	**222**	**226**	**1,872**	**736**
Arthrodesmus,	0	0	0	0	32	0
Chlorococcus,	0	0	0	0	252	0
Conferva,	0	0	10	0	0	0
Dictyosphærium,	0	0	0	0	10	0
Protococcus,	8	68	0	220	1,508	388
Raphidium,	2	1	12	0	0	84
Scenedesmus,	4	2	0	2	52	4
Selenastrum,	0	0	0	0	0	8
Staurastrum,	0	0	0	4	18	252
Zoöspores,	0	0	200	0	0	0
ANIMALS.						
Rhizopoda,	**2**	**0**	**0**	**0**	**0**	**4**
Actinophrys,	0	0	0	0	0	4
Arcella,	2	0	0	0	0	0
Infusoria,	**32**	**93**	**309**	**212**	**18**	**96**
Cryptomonas,	4	0	0	0	0	0
Dinobryon,	0	4	236	0	0	88
Dinobryon cases,	0	0	72	0	0	0
Euglena,	0	1	0	0	0	0
Mallomonas,	0	0	0	156	2	4
Peridinium,	0	0	1	0	0	4
Phacus,	0	0	0	0	2	0
Raphidomonas,	0	0	0	0	2	0
Trachelomonas,	28	88	0	56	12	0
Crustacea,	**0**	**0**	**0**	**0**	**.18**	**0**
Cyclops,	0	0	0	0	.16	0
Daphnia,	0	0	0	0	.02	0
Miscellaneous, Zoöglœa,	**20**	**120**	**60**	**20**	**0**	**100**
TOTAL,	238	377	921	501	2,242	1,184

HOLYOKE.

Chemical Examination of Water from Wright and Ashley Ponds, Holyoke.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid				Nitrates.	Nitrites.		
								Total.	Dissolved.	Sus-pended.					
	1896.														
16962	Jan. 27	Distinct.	V. slight.	.25	5.90	1.90	.0010	[illegible]	.0378	.0022	.18	.0100	.0001	.41	3.2
16321	Mar. 25	V. slight.	V. slight.	.10	5.45	1.45	.0006	.0182	.0158	.0024	.19	.0070	.0000	.19	3.7
16664	May 25	Distinct.	Slight, white.	.10	4.95	1.60	.0002	.0194	.0174	.0020	.25	.0050	.0000	.15	3.1
17058	July 27	Distinct.	Slight.	.12	5.80	1.45	.0012	.0208	.0184	.0024	.14	.0020	.0000	.31	2.9
17553	Sept. 24	Slight.	Slight.	.08	4.90	1.45	.0010	.0332	.0298	.0034	.20	.0020	.0000	.28	2.8
17948	Nov. 24	Decided.	Slight.	.10	5.75	1.60	.0017	.0260	.0182	.0078	.17	.0000	.0000	.21	3.1

Averages by Years.

-	1887*	-	-	.08	5.26	0.89	.0029	.0202	-	-	.13	.0016	-	-	-
-	1888	-	-	.06	4.31	0.82	.0024	.0178	-	-	.12	.0084	.0001	-	-
-	[illegible]	-	-	.02	5.37	0.74	.0020	.0201	.0161	.0040	.13	[illegible]	.0000	-	-
-	1890	-	-	.01	-	-	.0030	.0201	.0161	.0050	.13	[illegible]	.0000	-	-
-	1891†	-	-	.01	6.10	-	.0046	.0243	.0201	.0042	.13	.0035	.0001	-	2.9
-	1892‡	-	-	.03	5.10	1.15	.0008	.0196	.0154	.0042	17	[illegible]	.0000	-	3.1
-	1893	-	-	.06	4.71	1.21	.0036	.0195	.0152	.0043	15	.0072	.0000	[illegible]	3.1
-	1894	-	-	.09	5.14	1.38	.0022	.0215	.0179	.0036	.17	.0045	.0000	.26	2.9
-	1895	-	-	.20	5.41	1.68	.0042	.0255	.0225	.0030	.19	.0057	.0001	.34	3.0
-	1896	-	-	.13	5.37	1.54	.0010	.0263	.0229	.0034	[illegible]	.0043	.0000	.25	3.1

* June to December. † July and October. ‡ May.

NOTE to analyses of 1896: Odor, generally mouldy and grassy, occasionally fishy. —— The samples were collected from Ashley Pond.

HOLYOKE.

Microscopical Examination of Water from Wright and Ashley Ponds, Holyoke.

[Number of organisms per cubic centimeter.]

	1896.					
	Jan.	Mar.	May.	July.	Sept.	Nov.
Day of examination,	28	26	26	28	25	25
Number of sample,	15962	16321	16664	17058	17553	17948
PLANTS.						
Diatomaceæ,	**0**	**259**	**352**	**4**	**47**	**228**
Asterionella,	0	256	320	0	0	70
Cyclotella,	0	0	0	0	0	6
Diatoma,	0	0	0	0	3	0
Melosira,	0	0	0	4	17	128
Navicula,	0	0	2	0	0	2
Synedra,	0	3	24	0	26	6
Tabellaria,	0	0	6	0	1	16
Cyanophyceæ,	**0**	**0**	**0**	**23**	**154**	**85**
Anabæna,	0	0	0	20	7	1
Chroöcoccus,	0	0	0	0	4	0
Cœlosphærium,	0	0	0	1	5	0
Microcystis,	0	0	0	2	124	0
Oscillaria,	0	0	0	0	14	84
Algæ,	**0**	**76**	**19**	**12**	**41**	**40**
Protococcus,	0	76	15	4	40	40
Raphidium,	0	0	2	8	0	0
Scenedesmus,	0	0	2	0	1	0
ANIMALS.						
Infusoria,	**656**	**2,501**	**2**	**0**	**1**	**22**
Dinobryon,	508	2,496	0	0	0	10
Euglena,	0	1	1	0	0	0
Mallomonas,	0	0	0	0	1	0
Monas,	0	0	1	0	0	0
Peridinium,	148	2	0	0	0	6
Trachelomonas,	0	2	0	0	0	6
Vermes,	**2**	**1**	**2**	**0**	**2**	**0**
Anuræa,	0	0	1	0	0	0
Asplanchna,	2	0	0	0	0	0
Polyarthra,	0	0	1	0	1	0
Rotatorian ova,	0	1	0	0	1	0
Crustacea, Daphnia,	**0**	**0**	**0**	**0**	**0**	**.02**
Miscellaneous, Zoöglœa,	**0**	**0**	**20**	**0**	**20**	**100**
TOTAL,	658	2,837	395	39	265	475

WATER SUPPLY OF HOPEDALE.

(See *Milford.*)

HUDSON.

Water Supply of Hudson.

Chemical Examination of Water from Gates Pond, Berlin.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitra[redacted]	Nitrites.		
	1896.														
15885	Jan. 15	V. slight.	V. slight.	.04	2.50	1.35	.0064	.0164	.0132	.0032	.27	.0000	.0000	.16	1.1
16079	Feb. 18	Slight.	Slight.	.10	2.95	0.50	.0078	.0136	.0120	.0016	.33	.0140	.0001	.17	1.1
16261	Mar. 17	Slight.	Slight.	.08	2.65	[redacted]	[redacted]	.0134	.0120	.0014	.29	.0160	.0000	.22	1.0
16402	Apr. 14	Slight.	Slight.	.05	1.96	0.75	.0028	.0150	.0122	.[redacted]	.21	.0050	.0001	.17	0.8
16890	June 25	Slight.	Slight.	.04	2.30	0.60	.0000	.0146	.0124	.0022	.22	.0020	.0000	.17	0.9
17165	Aug. 11	V. slight.	V. slight.	.04	2.50	[redacted]	[redacted]	.0150	.0130	.0020	.28	[redacted]	.0000	.20	0.8
17622	Oct. 12	Distinct.	Cons.	.08	2.45	0.95	.0060	.0172	.0134	.0038	.24	.0030	.0000	.14	0.9
18016	Dec. 8	Distinct.	Slight.	.04	2.15	0.80	.0028	.0142	.0100	.0042	.24	[redacted]	.0000	.11	0.8

Averages by Years.

-	1887*	-	-	.06	3.17	0.71	.0014	.0160	-	-	.21	[redacted]	-	-	-
-	1888	-	-	.06	2.66	0.69	.0015	.0158	-	-	.19	.0055	.0001	-	-
-	1889	-	-	.09	2.74	0.58	.0020	.0189	.0139	.0050	.19	.0048	.0001	-	-
-	1890	-	-	.08	2.82	1.04	.0023	.0161	.0124	.0037	.21	.0054	.0000	-	1.2
-	1891	-	-	.04	2.52	0.90	.0011	.0150	.0117	.0033	.20	.0074	.0000	-	0.9
-	1893	-	-	.06	2.45	1.01	[redacted]	.0178	.0146	.0032	.23	.0039	.0000	.20	0.8
-	1894	-	-	.04	2.27	0.83	.0016	.0148	.0124	.0024	.23	.0008	[redacted]	.15	0.8
-	1895	-	-	.05	2.45	0.92	.0015	.0175	.0144	.0031	.23	.0027	.0000	.20	0.9
-	1896	-	-	[redacted]	2.43	0.84	.0037	.0150	.0123	.0027	.26	[redacted]	.0000	.17	0.9

* June to December.

NOTE to analyses of 1896: Odor, faintly vegetable, sometimes none, becoming somewhat stronger on heating. —— The samples were collected from the pond. For monthly height of water in this pond, see page 179.

HUDSON.

Microscopical Examination of Water from Gates Pond, Berlin.

[Number of organisms per cubic centimeter.]

	1896.							
	Jan.	Feb.	Mar.	Apr.	June.	Aug.	Oct.	Dec.
Day of examination,	16	19	17	15	26	12	13	9
Number of sample,	15885	16079	16261	16402	16690	17265	17622	18016
PLANTS.								
Diatomaceæ,	0	0	0	341	212	1	68	585
Asterionella,	0	0	0	0	192	0	0	404
Melosira,	0	0	0	324	8	0	8	172
Navicula,	0	0	0	4	0	0	0	0
Synedra,	0	0	0	13	4	0	56	5
Tabellaria,	0	0	0	0	8	1	4	4
Cyanophyceæ,	0	0	0	0	12	59	0	0
Clathrocystis,	0	0	0	0	0	19	0	0
Microcystis,	0	0	0	0	12	40	0	0
Algæ,	2	0	0	17	30	0	14	16
Protococcus,	2	0	0	15	30	0	10	0
Raphidium,	0	0	0	2	0	0	4	16
ANIMALS.								
Rhizopoda, Actinophrys,	0	0	0	1	0	0	0	0
Infusoria,	2	0	0	30	26	[illegible]	2	477
Codonella,	1	0	0	0	0	0	0	1
Dinobryon,	0	0	0	0	26	0	0	460
Euglena,	0	0	0	0	0	0	1	0
Mallomonas,	0	0	0	28	0	0	0	4
Monas,	0	0	0	1	0	0	1	0
Peridinium,	1	0	0	1	[illegible]	2	0	12
Vermes,	0	0	0	5	0	0	0	1
Anuræa,	0	0	0	5	0	0	0	0
Polyarthra,	0	0	0	0	0	0	0	1
Miscellaneous, Zoöglœa,	0	0	0	0	10	20	15	[illegible]
TOTAL,	4	0	0	394	290	82	99	1,092

Table showing Heights of Water in Gates Pond Each Month during 1896.

[High-water mark is 14 feet.]

DATE. — 1896.	Feet.	DATE. — 1896.	Feet.
Jan. 15,	9.68	July 15,	11.12
Feb. 15,	10.75	Aug. 15,	10.60
March 15,	11.76	Sept. 15,	10.25
April 15,	12.64	Oct. 15,	10.04
May 15,	12.17	Nov. 15,	9.96
June 15,	11.92	Dec. 15,	9.92

HUNTINGTON.

HUNTINGTON.

The advice of the State Board of Health to citizens of Huntington relative to the use of water from springs west of the village for domestic purposes may be found on pages 19 and 20 of this volume.

Chemical Examination of Water from Springs in Huntington.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16069	Feb. 15	V. slight.	Slight.	.10	3.05	.0010	.0068	.11	.0070	[illegible]	.18	0.5	–
16120	Feb. 24	None.	Slight, green.	.00	4.30	.0012	.0130	14	.0060	.0001	.04	0.6	.0010

Odor of the first sample, distinctly clayey; of the second, distinctly grassy. —— The first sample was collected from a faucet in the village supplied from a spring on the hillside, south of Westfield River, the last, from a spring near the road from Norwich bridge to Chester Center, about 2¼ miles from the village of Huntington.

Microscopical Examination.

An insignificant number of organisms was found in No. 16120; no organisms were found in the other sample.

Chemical Examination of Water from Cook or Roaring Brook and from Taylor Brook, in Huntington.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16070	Feb. 15	V. slight.	V. slight.	.10	3.40	1.20	.0000	.0058	.0050	.0008	.12	.0180	.0000	16	1.0
16119	Feb. 24	None.	V. slight.	.10	1.55	0.60	.0000	.0050	.0044	.0006	.12	.0030	.0001	.14	[illegible]

Odor of the first sample, distinctly clayey; of the second, none. —— The first sample was collected from Cook or Roaring Brook, and the second from Taylor Brook

Microscopical Examination.

An insignificant number of organisms was found in No. 16119; no organisms were found in the other sample.

WATER SUPPLY OF HYDE PARK AND MILTON. — HYDE PARK WATER COMPANY.

The advice of the State Board of Health to the Hyde Park Water Company, with reference to taking an additional supply of water

from the ground in the vicinity of Mother Brook in Dedham, may be found on pages 20 and 21 of this volume. Analyses of samples of water collected from test wells in this vicinity may be found in the table following the analyses of water from the Neponset River.

Chemical Examination of Water from the Wells of the Hyde Park Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15920	Jan. 21	None.	V. slight.	.02	9.10	.0056	.0024	1.13	.0980	.0008	.08	3.9	.0225
16078	Feb. 18	None.	None.	.02	[illegible]	.0054	.0032	1.01	.0800	.0008	.06	3.5	.0060
16266	Mar. 17	None.	None.	.02	7.75	.0054	.0026	0.96	.0720	.0001	.07	3.5	0100
16448	Apr. 21	None.	Slight.	.00	8.15	.0040	.0098	0.91	.0880	.0001	.02	3.8	0040
16817	May 19	None.	Slight, dark.	.30	9.05	.0048	.0040	1.09	.1050	.0002	.28	4.1	.0040
16931	June 16	Slight.	Cons.	.05	9.40	.0062	.0060	1.21	.1050	.0000	.04	4.2	.0050
17025	July 21	V. slight.	V. slight.	.05	10.20	.0092	.0046	1.15	.0900	0002	.12	4.3	.0060
17226	Aug. 18	Slight, white.	Slight.	.05	10.30	.0096	.0036	1.24	.0680	.0002	.14	4.4	.0040
17445	Sept. 14	Distinct.	Slight, rusty.	.07	11.55	.0156	.0070	1.62	.0560	.0007	.18	4.6	.0290
17659	Oct. 19	Distinct.	Slight.	.04	11.15	.0140	.0064	1.80	.0950	.0008	.13	4 6	0185
17876	Nov. 17	Distinct.	Slight.	.03	10.60	.0096	.0034	1.41	.1000	.0001	.11	4.3	.0275
18148	Dec. 15	None.	Slight, rusty.	.04	10.00	.0086	.0064	1.26	.1000	.0004	.10	4.4	.0330

Averages by Years.

-	1887*	-	-	.00	6.67	[illegible]	.0012	0.82	[illegible]	-	-	-	-
-	1888	-	-	.00	6.06	.0001	.0023	0.75	.0641	.0002	-	-	-
-	1889†	-	-	.00	5.76	.0001	.0019	0.68	.0598	.0001	-	-	-
-	1890‡	-	-	.02	9.35	.0006	.0023	0.88	.0550	.0002	-	4.2	-
-	1891§	-	-	.03	9.10	.0000	.0040	0.96	.0675	.0002	-	3.6	-
-	1892‖	-	-	.00	7.20	.0004	.0035	0.99	.0500	.0004	-	3.0	-
-	1893	-	-	.02	8.62	.0031	.0032	1.19	.0879	.0002	.10	3.7	.0112
-	1894	-	-	.03	9.68	.0040	0039	1.37	.0843	.0001	.09	3.9	.0175
-	1895	-	-	.04	9.44	.0063	0035	1.31	.0867	.0001	.09	4.0	.0149
-	[illegible]	-	-	.03	9.68	.0084	.0046	1.21	.0882	.0003	.11	4 1	.0141

* June to December. † January to May. ‡ February and August.
§ June and September. ‖ Two samples in July.

NOTE to analyses of 1896: Odor, none. — The samples were collected from a faucet at the pumping station.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

YDE PARK AND MILTON.

hemical Examination of Water from a Faucet in Milton supplied from the Works of the Hyde Park Water Company.

[Parts per 100,000.]

Number	Date of Collection.	Appearance. Turbidity	Sediment	Color.	Residue on Evaporation.	Ammonia. Free.	Albuminoid.	[illegible]	Nitrogen as Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
15901	Jan. 9	None.	None.	.00	10.80	.0000	.0018	1.78	.1600	.0000	.03	3.9	.0010
16018	Feb. 4	None.	V. slight.	.01	10.70	.0000	.0024	1.55	.1100	.0000	.07	4.2	.0150
16192	Mar. 4	None.	None.	.00	10.00	.0004	.0032	1.35	.1050	.0000	.07	3.8	.0040
16379	Apr. 9	None.	None.	.00	8.80	.0004	.0038	1.30	.1560	.0000	.02	3.6	.0060
16546	May 5	None.	None.	.00	10.70	.0006	.0010	1.51	.1900	.0000	.02	4.0	.0054
16782	June 4	None.	None.	.00	10.80	.0000	.0048	1.44	1500	.0000	10	4.4	.0020
16947	July 8	None.	None.	.01	10.20	.0000	.0030	1.34	0950	.0000	–	4.0	.0040
17128	Aug. 5	None.	None.	.03	9.80	.0010	.0044	1.43	1000	.0000	.09	4.0	.0030
17377	Sept. 8	None.	None.	.03	12.80	.0000	.0028	1.85	.1100	.0000	.04	4.4	.0020
17594	Oct. 7	None.	V. slight.	.04	11.30	.0000	.0044	1.31	.1000	.0000	.13	4.4	.0120
17757	Nov. 4	None.	None.	.02	10.60	.0004	.0040	1.78	.1400	.0000	.08	4.1	[illegible]
18003	Dec. 7	None.	V. slight.	.02	10.70	.0008	.0022	1.68	1020	.0000	.07	4.2	.0030
Av.	....	....	....	.01	10.66	.0003	.0031	1.57	1265	.0000	.07	4.1	.0053

Odor, generally none. On heating, a faintly earthy odor was developed in some of the samples.— The samples were collected from a faucet in the office of the Milton Water Company.

Microscopical Examination.

No organisms.

Chemical Examination of Water from the Neponset River at Hyde Park.

[Parts per 100,000.]

Number	Date of Collection.	Appearance. Turbidity.	Sediment.	Color.	Residue on Evaporation. Total	Loss on Ignition	Ammonia. Free.	Albuminoid Total.	Dissolved.	Suspended	Chlorine.	Nitrogen as Nitrates	Nitrites	Oxygen Consumed.	Hardness.
	1896.														
15919	Jan 21	Distinct.	Slight.	1.00	6.25	2.40	.0012	.0258	.0212	.0046	0.70	.0230	.0002	0.83	1.
16077	Feb. 18	Slight.	Slight.	0.90	5.65	2.15	.0006	.0200	.0184	.0016	0.57	.0120	.0001	0.74	1.
16267	Mar 17	V. slight.	V. slight.	0.80	4.85	2.00	.0008	.0200	.0180	.0020	0.58	.0100	.0001	0.69	1
16447	Apr 21	Decided.	Cons., rusty.	1.15	5.70	2.35	.0126	.0404	.0316	.0085	0.52	.0050	.0001	1.00	1
16616	May 19	Decided.	Cons.	1.10	6.55	2.35	.0486	.0348	.0310	.0038	1.25	.0050	.0001	1.12	?
16830	June 16	Distinct	Cons.	1.18	6.80	2.60	.0064	.0364	.0330	.0034	0.85	.0020	.0002	1.20	.
17024	July 21	Distinct.	Cons. rusty.	1.00	12.10	2.75	.0112	.0440	.0370	.0070	2.20	.0030	.0001	0.82	
17225	Aug. 18	Distinct.	Cons.	0.70	15.66	2.80	.0640	.0440	.0398	.0042	3.29	.0020	.0001	1.09	
17444	Sept. 14	Distinct.	Cons.	2.00	10.40	4.45	.0126	.0612	.0584	.0028	1.26	.0040	.0001	1.86	
17658	Oct. 19	Distinct.	Slight.	1.50	9.75	3.60	.0020	.0440	.0414	.0026	1.42	.0020	.0001	–	
17875	Nov. 17	Distinct, floc.	Cons.	1.20	7.75	2.85	.0012	.0202	.0276	.0016	1.10	.0070	.0001	1.33	
18147	Dec. 15	Distinct.	Slight.	0.90	6.80	2.30	.0032	.0234	.0202	.0032	0.96	.0180	.0003	1.00	

HYDE PARK AND MILTON.

Chemical Examination of Water from the Neponset River at Hyde Park — Concluded.

Averages by Years.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
-	1887*	-	-	1.19	8.35	2.30	.0053	.0400	-	-	0.99	.0080	-	-	-
-	1888	-	-	1.02	6.77	2.27	.0030	.0324	-	-	0.83	.0096	.0002	-	-
-	1891†	-	-	1.48	11.40	3.45	.0190	.0510	.0418	.0097	1.16	.0065	.0003	-	3.3
-	1892‡	-	-	0.90	13.30	2.85	.0260	.0324	.0286	.0038	2.81	.0090	.0012	-	4.4
-	1893	-	-	1.16	7.70	2.49	.0151	.0320	.0254	.0066	1.19	.0154	.0005	0.95	2.4
-	1894	-	-	1.14	9.68	2.69	.0112	.0360	.0277	.0083	1.64	.0062	.0002	1.00	3.0
-	1895	-	-	1.04	8.40	2.81	.0182	.0365	.0312	.0053	1.18	.0064	.0001	1.05	3.0
-	1896	-	-	1.12	8.55	2.69	.0137	.0353	.0315	.0068	1.22	.0077	.0001	1.06	2.7

* June to December. † August and September. ‡ July.

Note to analyses of 1896: Odor, generally decidedly vegetable and musty or disagreeable, and occasionally offensive. —— The samples were collected from the river, opposite the works of the Hyde Park Water Company. The river is not used directly as a source of water supply.

Chemical Examination of Water from Test Wells in Dedham.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity	Sediment.	Color.		Free.	Albuminoid.		Nitrates	Nitrites.			
	1896.												
17562	Sept. 29	None.	None.	.02	4.40	.0000	.0002	0.51	.0400	.0000	.01	2.0	.0060
17806	Nov. 9	None.	None.	.00	9.10	.0006	.0012	1.17	.2000	.0000	.01	3.4	.0050
17931	Nov. 20	None.	None.	.00	9.20	.0002	.0006	1.22	.3400	.0000	.14	3.1	.0020

Odor, none. —— The samples were collected from tubular test wells in the valley of Mother Brook in Dedham, near the line between the towns of Hyde Park and Dedham. —— The first sample was collected from a well on the northerly side of the brook; the last two, from a well on the southerly side of the brook.

Microscopical Examination.

No organisms.

IPSWICH.

Water Supply of Ipswich.

The advice of the State Board of Health to the water board of Ipswich, relative to the protection of the purity of the water of Dow's Brook storage reservoir, may be found on pages 71 and 72 of this volume. Analyses of samples of water collected from several small streams entering the reservoir are given in the following tables: —

Chemical Examination of Water from Dow's Brook above the Storage Reservoir of the Ipswich Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15950	Jan. 27	None.	V. slight.	.53	4.20	1.40	.0004	.0118	.0102	.0016	.57	.0030		.63	1.6
16118	Feb. 24	Slight.	Slight.	.27	4.00	1.10	.0006	.0092	.0074	.0018	.47	.0050	.0000	.30	1.7
16311	Mar. 23	V. slight.	Slight.	.42	3.44	1.25	.0000	.0114	.0096	.0018	.40	.0050	.0000	.47	1.1
16495	Apr. 28	V. slight.	Slight.	.50	4.05	1.20	.0008	.0120	.0106	.0014	.45	.0050	.0002	.45	1.6
16667	May 25	Slight.	Slight.	.22	3.85	1.00	.0002	.0060	.0048	.0012	.49	.0050	.0000	.16	1.6
16878	June 22	None.	Slight.	.15	4.25	0.75	.0004	.0058	.0042	.0016	.56	.0056	.0000	.18	1.8
17060	July 27	Distinct.	Slight.	.25	5.05	1.60	.0046	.0250	.0198	.0052	.70	.0030	.0000	.38	2.0
17273	Aug. 24	Slight.	Slight.	.22	4.95	1.65	.0018	.0202	.0182	.0020	.72	.0070	.0000	.89	1.7
17539	Sept. 22	V. slight.	V. slight.	.50	5.70	1.70	.0008	.0144	.0128	.0016	.59	.0030	.0000	.56	1.5
17755	Oct. 20	V. slight.	Slight.	.65	4.90	2.25	.0004	.0110	.0104	.0006	.64	.0030	.0000	.77	1.6
17954	Nov. 24	None.	Slight.	.50	5.10	1.40	.0002	.0114	.0104	.0010	.58	.0050	.0000	.65	1.9
18158	Dec. 21	V. slight.	Slight.	.38	4.55	1.25	.0012	.0086	.0076	.0010	.62	.0050	.0001	.56	1.8
Av.	1896	....	....	.38	4.45	1.39	.0009	.0122	.0105	.0017	.57	.0045	.0000	.46	1.7
Av.	1895	....	....	.47	4.74	1.62	.0006	.0129	.0111	.0018	.61	.0042	.0001	.46	1.6

Note to analyses of 1896. Odor, generally faintly vegetable, sometimes none. All of the samples had vegetable odors when heated. —— The samples were collected from the brook, at its entrance to the storage reservoir.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 25.

IPSWICH.

Chemical Examination of Water from Brooks Tributary to the Dow's Brook Storage Reservoir, Ipswich.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16492	Apr. 28	V. slight.	Slight.	.25	5.10	1.15	.0012	.0122	.0110	.0012	0.81	.0080	.0002	.26	1.9
16493	Apr. 28	Distinct.	Cons.	.20	17.60	2.35	.1280	.0530	.0410	.0120	4.55	.0420	.0055	.36	3.4
16494	Apr. 28	Slight.	Slight.	.18	5.15	1.45	.0006	.0114	.0100	.0014	0.93	.0300	.0002	.23	2.2

Odor of the first and last samples, vegetable; of the second, unpleasant. —— The first sample was collected from Bailey Brook, as it enters the reservoir; the second, from a drain from several buildings, as it enters the reservoir; the last, from Jewett's Brook, as it enters the reservoir.

Microscopical Examination.

No. 16492. Diatomaceæ, *Melosira*, 7; *Meridion*, 4; *Navicula*, 36; *Synedra*, 1; *Tabellaria*, 19. Algæ, *Staurastrum*, 1. Total, 68.

No. 16493. Diatomaceæ, *Navicula*, 28; *Pinnularia*, 60. Algæ, *Closterium*, 6; *Staurastrum*, 1; *Spirogyra*, 2. Fungi, *Molds*, 10. Rhizopoda, *Actinophrys*, 1. Infusoria, *Euglena*, 1; *Paramæcium*, 1; *Synura*, 2. Vermes, *Anguillula*, 1. Miscellaneous, *Zoöglœa*, 40. Total, 173.

No. 16494. Diatomaceæ, *Asterionella*, 4; *Meridion*, 22; *Navicula*, 7; *Pinnularia*, 1; *Synedra*, 16; *Tabellaria*, 12. Algæ, *Staurastrum*, 1. Total, 63.

Chemical Examination of Water from the Storage Reservoir of the Ipswich Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	[redacted].														
16031	Jan. 27	Distinct, clayey.	Slight, earthy.	.38	4.25	1.40	.0028	.0156	.0114	.0042	.58	.0050	.0000	.44	1.6
16312	Mar. 23	Distinct, clayey.	Slight, earthy.	.32	3.55	1.45	.0042	.0154	.0142	.0012	.55	.0070	0000	.42	1 4
16496	Apr. 28	Distinct.	V. slight.	.38	3.30	1.15	.0032	.0186	.0176	.0010	.58	.0080	.0002	.42	0.9
16664	May 25	Slight.	Slight.	.30	3.95	1.55	.0014	.0122	.0110	.0012	.63	.0080	.0001	.29	1.5
16874	June 22	Slight.	Slight.	.25	4.35	1.30	.0014	.0114	.0104	.0010	.69	.0050	.0001	.38	1.7
17061	July 27	Slight.	Slight.	.25	4.90	1.15	.0012	.0134	.0104	.0030	.60	.0070	.0001	.26	1.9
17274	Aug. 24	Slight.	Slight.	.20	4.95	1.55	.0016	.0208	.0182	.0026	.72	.0030	.0000	.33	1.8
17540	Sept. 22	Distinct, green.	Slight, green.	.48	4.85	1.65	.0014	.0230	.0182	.0048	.68	.0000	.0000	.41	1.7
17756	Oct. 30	Distinct.	Slight.	.32	5.65	2.10	.0004	.0250	.0186	.0064	.79	.0020	.0001	.44	1.8
17955	Nov. 24	Slight.	Slight.	.37	5.65	1.80	.0008	.0220	.0178	.0042	.79	.0070	.0002	.52	1.9
18159	Dec. 21	Distinct.	Slight.	.37	5.20	1.85	.0008	.0182	.0136	.0046	.78	.0120	.0001	.57	2.1
Av....	1896	....	....	.32	4.60	1.54	.0017	.0178	.0147	.0031	.67	.0056	.0001	.41	1.7
Av....	1895	....	....	.45	5.25	1.69	.0022	.0194	.0169	.0025	.76	.0072	.0001	.50	1.9

NOTE to analyses of 1896: Odor, generally faintly vegetable, often also mouldy, becoming stronger on heating. —— The samples were collected from the reservoir.

IPSWICH.

Microscopical Examination of Water from the Storage Reservoir of the Ipswich Water Works.

[Number of organisms per cubic centimeter.]

	1896.										
	Jan.	Mar.	Apr	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec
Day of examination,	28	25	30	26	24	23	25	23	21	25	22
Number of sample,	15951	16312	16496	16668	16874	17061	17274	17540	17756	17956	18189
PLANTS.											
Diatomaceæ,	3	1	24	1	2	2	6	4	22	24	3
Melosira,	3	0	0	0	0	0	5	4	0	0	0
Synedra,	0	1	24	1	2	2	1	0	22	24	3
Algæ,	1	0	0	4	1	0	5	16	24	60	50
Chlorococcus,	0	0	0	0	0	0	0	7	0	0	0
Protococcus,	0	0	0	0	0	0	1	1	0	12	0
Raphidium,	1	0	0	4	0	0	0	0	6	4	5
Scenedesmus,	0	0	0	0	0	0	0	0	2	4	1
Staurastrum,	0	0	0	0	1	0	0	0	0	0	44
Staurogenia,	0	0	0	0	0	0	4	8	16	40	0
ANIMALS.											
Infusoria,	3	0	4	0	0	0	1	0	14	246	11
Dinobryon,	3	0	2	0	0	0	0	0	12	244	9
Peridinium,	0	0	2	0	0	0	0	0	0	0	2
Trachelomonas,	0	0	0	0	0	0	1	0	2	2	0
Crustacea, Daphnia,	0	0	0	0	0	.02	0	.02	0	0	0
Miscellaneous, Zoöglœa,	0	0	0	0	0	0	20	15	0	5	80
TOTAL,	7	1	28	5	3	2	32	35	60	335	144

IPSWICH.

Chemical Examination of Water from Bull Brook, Ipswich.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16117	Feb. 24	Slight.	Slight.	1.00	5.60	2.00	.0016	.0194	.0178	.0016	.61	.0140	.0000	0.86	1.8
16310	Mar. 23	V. slight.	Slight.	1.10	4.55	1 95	.0000	.0180	.0166	.0014	.53	.0070	[illegible]	0.94	1.3
16497	Apr. 28	None.	V. slight.	1.90	5.90	2.75	.0012	.0270	.0254	.0016	.61	.0070	.0002	1.34	1.8
16666	May 25	Slight.	Slight.	1.30	6.50	2.45	.0006	.0156	.0148	.0008	.69	.0050	.0001	0.78	2.6
16872	June 22	V. slight.	V. slight.	1.20	7.55	2.50	.0014	.0182	.0172	.0010	70	.0080	.0001	1.23	2.6
17062	July 27	V. slight.	Slight.	0.87	6.85	1.60	.0002	.0170	.0128	.0042	.80	.0070	0001	0.30	3.2
17272	Aug. 24	Slight.	Slight.	0.38	6.55	1.40	.0018	.0108	.0082	.0026	.77	.0080	.0000	0.27	3.0
17538	Sept. 22	None.	V. slight.	2.60	11.15	6 50	0034	.0622	.0606	.0016	.87	.0030	.0000	4.03	2.6
17754	Oct. 30	V slight.	Slight.	1.80	8.40	4.45	.0002	.0390	.0322	.0068	.94	.0030	[illegible]	1.92	2.5
17953	Nov. 24	None.	Slight.	1.30	7.70	3.30	.0002	.0304	.0284	.0020	.80	.0100	.0000	1.42	2.5
18157	Dec. 21	V. slight.	Slight.	0.66	5.90	1.85	[illegible]	.0196	.0162	.0034	.76	.0100	.0001	0.94	2.1
Av.	......	....	....	1.23	6.96	2.80	.0010	.0252	.0227	.0025	.74	.0075	.0001	1.26	2.4

Odor of the fourth sample, none; of the others, generally distinctly vegetable, sometimes mouldy, becoming stronger on heating. —— The samples were collected from the brook, near its junction with Dow's Brook, below the storage reservoir of the Ipswich water works. This brook is not used as a source of water supply.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 255.

Chemical Examination of Water from the Distributing Reservoir of the Ipswich Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
17718	Oct. 26	Slight.	Slight.	.10	5.30	1.80	.0000	.0180	.0174	.0006	.75	.0050	.0000	.29	2.1

Odor, faintly vegetable. —— The sample was collected from the distributing reservoir on Town Hill.

Microscopical Examination.

No. 17718. Diatomaceæ, *Synedra*, 4. Algæ, *Cosmarium*, 1; *Protococcus*, 1; *Raphidium*, 2, *Staurogenia*, 16. Infusoria, *Dinobryon*, 11. Total, 34.

IPSWICH.

Chemical Examination of Water from Faucets supplied from the Ipswich Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
17719	Oct. 26	V. slight.	V. slight.	.12	5.20	1.15	.0002	.0160	.0138	.0022	.72	.0020	.0000	.19	2.2
17720	Oct. 26	V. slight.	V. slight.	.10	5.30	1.15	.0004	.0196	.0166	.0030	.73	.0050	.0000	.23	2.1

Odor, faintly vegetable.—The samples were collected from faucets in the town.

Microscopical Examination.

No. 17719. Diatomaceæ, *Synedra*, 4. Algæ, *Protococcus*, 5. Total, 9.
No. 17720. Diatomaceæ, *Cyclotella*, 2; *Synedra*, 9. Algæ, *Protococcus*, 5; *Scenedesmus*, 1; *Staurogenia*, 8; *Trachelomonas*, 1. Total, 26.

Water Supply of Kingston.

The advice of the State Board of Health to the town of Kingston, relative to securing an additional supply of water from the ground in the valley of Furnace Brook in that town, may be found on pages 21 to 23 of this volume.

Chemical Examination of Water from Faucets supplied from the Kingston Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	[illegible].												
15947	Jan 25	None.	V. slight	.13	4.50	.0010	.0016	.81	.0500	.0000	.12	1.6	.0240
16276	Mar. 17	None.	None.	.08	5.10	.0006	.0026	.83	.0420	.0000	.12	1.6	.0170
16600	May 13	V. slight	V. slight	.06	4.90	.0034	.0024	.58	.0600	.0000	.05	1.3	.0260
16611	May 18	V. slight	V. slight	.33	4.60	.0002	.0076	.73	.0340	.0000	.36	1.3	–
17597	Oct. 6	V. slight.	V. slight	.12	5.60	.0048	.0024	.85	.0500	.0000	.21	1.4	.0620
17867	Nov. 16	Slight, milky.	Slight, rusty.	.20	5.50	.0038	.0062	.90	.0300	.0000	.32	1.5	.0500
Av.*	....	....	....	.15	5.09	.0018	.0036	.84	.0438	.0000	.19	1.5	.0315

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor of the first three and last samples, none; of the fourth, very faintly vegetable, becoming stronger on heating; of the fifth, none, becoming faintly earthy on heating.—The last sample was collected from a faucet in the town, the others, from a faucet at the pumping station.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows: No. 15947, 20; No 16276, 782; No. 16600, 2,500; No. 16611, 1,250; No. 17597, 4,000, No. 17867, 960; consisting chiefly of *Crenothrix*.

KINGSTON.

Chemical Examination of Water from Pine and Howard Brooks in Kingston.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
17137	Aug 20	Distinct.	Cons.	0.95	4.25	1.30	.0010	.0198	.0184	.0014	.77	.0020	.0001	0.66	0.2
17138	Aug 5	V. slight.	Slight.	1.50	5.60	2.70	.0010	.0274	.0228	.0046	.94	.0030	.0000	1.25	0.2

Odor of the first sample, faintly vegetable; of the second, faintly vegetable, becoming distinctly unpleasant on heating. —— The first sample was collected from Pine Brook, at the first road crossing above its junction with Howard Brook; the last, from Howard Brook, at the first road crossing above its junction with Pine Brook, and just below a small mill pond. The samples were collected in connection with an investigation for an additional water supply for Brockton.

Microscopical Examination.

The total number of organisms per cubic centimeter found in each of these samples was as follows: No. 17137, 128; No. 17138, 142.

Chemical Examination of Water from Tubular Test Wells in the Valley of Furnace Brook, Kingston.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16597	May 13	None.	None.	.00	4.20	.0000	.0014	.80	.0090	.0000	.00	1.3	.0010
16598	May 13	None.	None.	.00	4.60	.0002	.0020	.75	.0030	.0000	.00	1.4	.0010
16599	May 13	None.	None.	.00	3.90	.0000	.0006	.68	.0030	.0000	.00	1.4	.0010
16693	June 1	None.	Cons., sandy.	.00	4.70	.0002	.0002	.71	.0030	.0000	.01	0.9	.0010
16721	June 3	None.	None.	[illegible]	4.30	.0000	.0004	.71	.0030	.0000	.02	1.3	.0020
16735	June 5	None.	None.	.00	4.60	.0000	.0004	.72	.0030	.0000	.04	1.0	.0000
16771	June 11	None.	None.	.00	4.90	.0000	.0014	.69	.0050	.0000	.06	1.2	.0010
16772	June 11	-	-	.00	-	-	-	-	-	-	-	0.8	.0040
16773	June 11	-	-	.00	-	-	-	-	-	-	-	1.9	.0010

Odor, none. —— The first three samples were collected from individual wells in a group of seven wells in the valley of Furnace Brook, below the dam of Maglathlin's tack factory. No. 16599 was collected from the well nearest the dam, and No. 16598 from the well farthest down the stream. Samples Nos. 16693, 16721, 16735 and 16771 were collected during a pumping test made by pumping from three wells about 600 feet below the tack factory, at a rate said to be equivalent to 245,000 gallons per day. The first of these samples was collected on the first day of the test, about two hours after pumping began; the second, after pumping thirty-nine hours continuously; the third, after pumping continuously for four days; and the last, after pumping ten days. Sample No. 16772 was collected from a test well near the group of wells connected with the pumps, just after pumping was discontinued; and sample No. 16773 was collected from a test well about 300 feet below the tack factory dam, just after the pumping test from the wells farther down the valley had been discontinued.

Microscopical Examination.

An insignificant number of organisms was found in No. 16721; no organisms were found in the remaining samples.

Water Supply of Lancaster.

(See *Clinton*.)

LAWRENCE.

WATER SUPPLY OF LAWRENCE.

The following tables contain analyses of the unfiltered Merrimack River water, and of the filtered water at the pumping station and at the distributing reservoir. The results of more extended chemical and biological examinations of the water before and after filtration through the sand filter may be found in a subsequent portion of this report, in the chapter on "Filtration of Water."

Chemical Examination of Water from the Merrimack River above Lawrence, opposite the Intake of the Lawrence Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1896.														
15931	Jan. 22	Distinct.	Cons.	.33	4.15	1.55	[redacted]	.0156	.0134	.0022	.20	.0120	.0001	.47	1.4
16100	Feb. 19	Distinct, milky.	Slight.	.40	4.60	1.50	.0006	.0200	.0142	.0058	.20	.0150	.0001	.52	1.1
16284	Mar. 18	Distinct, clayey.	Slight.	.40	3.05	1.10	.0014	.0142	.0126	.0016	.15	.0120	.0001	.42	1.0
16469	Apr. 22	Decided.	Cons., earthy.	.55	2.45	0.55	.0010	.0162	.0132	.0020	.13	.0070	.0000	.50	0.8
16645	May 20	Slight.	Cons.	.32	3.75	1.40	.0050	.0204	.0172	.0032	.23	.0070	.0004	.46	1.4
16820	June 17	Distinct.	Cons.	.50	3.70	0.95	.0066	.0200	.0172	.0028	.14	.0060	.0003	.58	1.0
17041	July 22	Distinct.	Cons.	.25	4.00	1.50	.0170	.0226	.0166	.0060	.36	.0050	.0012	.33	1.2
17249	Aug. 19	Distinct.	Cons.	.25	3.96	1.35	.0182	.0212	.0168	.0044	.28	.0070	.0006	.37	1.3
17493	Sept. 16	Distinct.	Cons.	.60	4.70	2.15	.0134	.0224	.0188	.0036	.28	.0100	.0005	.55	1.4
17695	Oct. 21	Distinct.	Cons.	.70	4.70	2.10	.0066	.0252	.0230	.0022	.24	.0050	.0005	.92	1.4
17892	Nov. 18	Slight.	Slight.	.48	4.40	2.15	.0014	.0228	.0162	.0066	.23	.0070	.0002	.57	1.6
18141	Dec. 16	Distinct, clayey.	Cons.	.40	4.40	1.65	.0092	.0444	.0398	.0046	.40	.0120	.0008	.68	1.3

Averages by Years.

-	1887*	-	-	.47	4.52	1.94	.0027	.0211	-	-	.23	.0097	-	-	-
-	1888	-	-	.30	3.68	1.08	.0026	.0180	-	-	.18	.0094	.0002	-	-
-	1889	-	-	.30	3.99†	0.87†	.0030	.0176	.0144	.0032	.17	.0072	.0003	-	-
-	1890	-	-	.38	4.19‡	1.48‡	.0046	.0166	.0132	.0034	.17	.0089	.0001	-	1.0§
-	1891	-	-	.27	3.79	1.22	.0040	.0152	.0121	.0031	.18	.0110	.0001	-	1.3
-	1892	-	-	.48	4.12	1.47	.0042	.0181	.0152	.0029	.18	.0105	.0001	-	1.4
-	1893	-	-	.42	3.86	1.48	.0057	.0181	.0141	.0040	.20	.0081	.0002	.53	1.1
-	1894	-	-	.37	3.70	1.30	.0062	.0167	.0141	.0026	.23	.0063	.0001	.44	1.2
-	1895	-	-	.51	4.34	1.75	.0064	.0249	.0185	.0064	.28	.0071	.0002	.59	1.4
-	1896	-	-	.42	3.98	1.52	.0068	.0220	.0183	.0037	.24	.0067	.0003	.58	1.2

* June to November. † January to May. ‡ August to December. § July to December.

NOTE to analyses of 1896: Odor, vegetable or musty. —— The samples were collected from the river, opposite the intake of the Lawrence water works, about 1 foot beneath the surface. For a record of the quantity of water flowing in the river on dates when samples of water were collected for analysis, see page 194. For a comparison of the analyses of the river water at Lowell and Lawrence for a series ... see "Merrimack River," in the chapter on "Examination of Rivers."

LAWRENCE.

Microscopical Examination of Water from the Merrimack River above Lawrence, opposite the Intake of the Lawrence Water Works.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	23	20	19	24	22	16	23	20	17	23	19	17
Number of sample,	15931	16100	16284	16469	16645	16820	17041	17249	17483	17695	17892	18141
PLANTS.												
Diatomaceæ,	1	5	11	12	137	[illegible]	228	82	43	10	5	7
Asterionella,	0	4	0	0	10	12	[illegible]	24	1	0	0	0
Diatoma,	0	0	0	0	0	0	8	0	0	0	0	0
Fragilaria,	0	0	0	0	0	0	12	4	1	0	0	0
Melosira,	0	0	0	5	0	0	40	0	9	0	0	0
Navicula,	0	0	2	0	1	3	16	0	2	4	2	2
Pinnularia,	0	0	0	0	0	0	16	2	0	0	0	0
Synedra,	1	1	8	5	112	156	75	44	30	6	3	5
Tabellaria,	0	0	5	1	14	16	0	8	0	0	0	0
Cyanophyceæ, Microcystis,	0	0	0	0	0	0	24	0	0	0	0	0
Algæ,	0	0	0	0	2	27	[illegible]	56	4	0	0	0
Pediastrum,	0	0	0	0	0	1	4	4	0	0	0	0
Protococcus,	0	0	0	0	2	26	23	24	2	0	0	0
Raphidium,	0	0	0	0	0	0	16	0	1	0	0	0
Scenedesmus,	0	0	0	0	0	0	16	4	1	0	0	0
Selenastrum,	0	0	0	0	0	0	32	16	0	0	0	0
Staurogenia,	0	0	0	0	0	0	0	8	0	0	0	0
Fungi,	0	0	0	0	0	7	0	0	2	0	0	40
Crenothrix,	0	0	0	0	0	7	0	0	0	0	0	0
Leptothrix,	0	0	0	0	0	0	0	0	2	0	0	40
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	0	2	1	0	0	3	0	0	0
Infusoria,	2	0	1	0	4	4	[illegible]	2	6	2	1	0
Ciliated infusorian,	0	0	0	0	0	0	0	0	2	0	0	0
Cryptomonas,	0	0	0	0	2	0	0	0	1	0	0	0
Dinobryon,	0	0	0	0	0	3	0	2	1	0	0	0
Monas,	2	0	0	0	2	1	5	0	1	2	1	0
Peridinium,	0	0	1	0	0	0	0	0	1	0	0	0
Vermes, Anuræa,	0	0	0	0	0	0	[illegible]	2	0	0	[illegible]	0
Crustacea, Daphnia,	0	0	0	0	.0	0	0	.02	0	0	0	0
Miscellaneous, Zoöglœa,	50	0	5	0	120	100	300	200	120	100	40	80
Total,	53	5	17	12	265	325	656	342	178	112	46	107

LAWRENCE.

Chemical Examination of Water from the Force Main at the Pumping Station of the Lawrence Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15933	Jan 22	Decided.	Cons., rusty	.33	6.65	1.65	.0260	.0116	.0070	.0046	.31	.0670	.0001	.26	2.9
16101	Feb 19	None.	V. slight.	.40	4.25	1.20	.0045	.0092	.0080	.0012	.20	.0200	.0000	.43	1.1
16286	Mar. 18	Distinct, clayey.	Slight.	.43	5.20	1.40	.0190	.0068	.0062	.0006	.25	.0280	.0001	.24	2.3
16470	Apr. 22	Slight.	Slight.	.35	2.90	1.00	.0070	.0088	.0072	.0016	.13	.0200	.0000	.35	1.3
[illegible]	May 20	Distinct, milky.	Slight.	.40	5.60	1.40	.0102	.0076	.0068	.0008	.30	.0420	.0004	.21	[illegible]
16821	June 17	Distinct, milky.	Slight.	.35	5.35	2.20	.0074	.0096	.0076	.0020	.18	.0480	.0000	.30	2.5
17042	July 22	Distinct, milky.	V. slight.	.25	5.40	1.65	.0072	.0092	.0064	.0028	.24	.0800	.0011	.19	2.3
17250	Aug. 19	Distinct.	Slight, rusty.	.15	4.45	1.40	.0020	.0076	.0056	.0020	.26	.0160	.0001	.24	2.0
17464	Sept. 16	Decided, milky	Slight, rusty.	.20	6.95	1.65	.0130	.0104	.0074	.0030	.33	.0300	.0007	.24	[illegible]
17696	Oct. 21	Distinct, milky.	Slight, rusty.	.73	6.75	2.15	.0172	.0122	.0110	.0012	.28	.0300	.0015	.53	3.4
17893	Nov. 18	V. slight.	V. slight.	.75	6.95	2.35	.0220	.0130	.0104	.0026	.29	.0400	.0008	.39	3.0
18142	Dec. 16	None.	V. slight.	.42	4.35	1.40	.0090	.0132	.0118	.0014	.35	.0180	[illegible]	.47	1.9

Averages by Years.

-	1894	-	-	.39	6.10	1.41	.0108	[illegible]	.0081	[illegible]	.30	.0309	.0002	.29	2.3
-	1895	-	-	.60	5.95	1.70	.0146	[illegible]	.0094	.0014	.31	.0274	.0001	.36	2.7
-	1896	-	-	.40	5.43	1.64	.0121	.0099	.0079	.0020	[illegible]	.0319	.0004	.32	2.4

NOTE to analyses of 1896. Odor, generally vegetable or earthy, occasionally none. —— The samples were collected from a faucet in the check-valve, just beyond the pump, and represent water from the river which has passed through the sand filter, mingled with a small amount of ground water, containing considerable free ammonia and iron.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows: No. 15933, 1,600; No. 16101, 10; No. 16286, 65; No 16470, 65; No. 16646, 324; No. 16821, 120; No. 17042, 360; No. 17250, 80; No. 17484, 700; No. 17696, 60; No. 17893, 300; No. 18142, 10; consisting chiefly of *Crenothrix.*

LAWRENCE.

Chemical Examination of Water from the Distributing Reservoir of the Lawrence Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	D[illegible]ved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15982	Jan. 22	None.	V. slight.	.38	4.65	1.80	.0046	.0122	.0114	.0008	.23	.0250	.0000	.43	1.6
16102	Feb. 19	V. slight.	None.	.35	4.55	1.35	.0056	.0138	.0096	.0040	.23	.0280	.0000	.36	1.8
16285	Mar. 18	Slight, clayey.	Slight.	.30	4.10	1.45	.0064	.0188	.0102	.0086	.19	.0250	.0000	.32	1.7
16471	Apr. 22	Slight.	Slight.	.28	3.45	1.10	.0040	.0080	.0068	.0012	.16	.0230	.0000	.30	0.8
16647	May 20	V. slight, milky.	Slight.	.25	4.15	1.10	.0020	.0086	.0072	.0014	.19	.0280	.0001	.25	1.8
16822	June 17	Slight.	Slight.	.26	4.30	1.55	.0014	.0092	.0075	.0017	.22	.0280	.0000	.28	1.9
17043	July 22	V. slight.	V. slight.	.18	4.90	1.30	.0010	.0104	.0076	.0028	.32	.0280	.0002	.17	1.9
17251	Aug. 19	Distinct.	Slight.	.15	4.55	1.35	.0020	[illegible]	.0076	.0080	.30	.0250	.0001	.24	2.1
17486	Sept. 16	Slight.	Slight.	.18	4.95	1.70	.0014	.0074	.0064	.0010	.29	.0300	.0001	.19	2.1
17697	Oct. 21	V. slight.	Slight.	[illegible]	5.20	1.66	.0036	.0112	.0096	.0014	.27	.0230	.0008	.36	2.7
17894	Nov. 18	None.	V. slight.	.40	5.15	1.25	.0034	.0136	.0114	.0022	.23	.0280	.0003	.46	2.3
18143	Dec. 16	V. slight.	V. slight.	.40	4.35	1.30	.0054	.0112	.0063	.0050	.24	.0250	.0001	.45	2.1
Av.	....	....	....	[illegible]	4.52	1.49	.0035	.0118	.0087	.0036	.24	.0259	.0001	[illegible]	1.9

Odor of the last three samples, none; of the others, vegetable and earthy, occasionally mouldy, becoming somewhat stronger on heating.——The samples were collected from a faucet at the gate-house, and represent water flowing out of the reservoir. The reservoir is supplied with filtered water.

Microscopical Examination of Water from the Distributing Reservoir of the Lawrence Water Works.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	23	20	19	24	22	18	23	21	17	23	19	18
Number of sample,	15982	16102	16285	16471	16647	16822	17043	17251	17486	17697	17894	18143
PLANTS.												
Algæ,	0	0	2	2	0	44	156	8	2	0	0	0
Protococcus,	0	0	0	2	0	33	156	8	2	0	0	0
Raphidium,	0	0	2	0	0	11	0	0	0	0	0	0
Fungi,	0	900	1,384	0	0	0	0	0	20	120	20	10
Crenothrix,	0	0	1,384	0	0	0	0	0	20	120	20	10
Leptothrix,	0	900	0	0	0	0	0	0	0	0	0	0

LAWRENCE.

Microscopical Examination of Water from the Distributing Reservoir of the Lawrence Water Works — Concluded.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.												
Infusoria,	0	4	0	3	0	0	0	0	0	0	0	0
Dinobryon,	0	0	0	3	0	0	0	0	0	0	0	0
Monas,	0	2	0	0	0	0	0	0	0	0	0	0
Paramecium,	0	2	0	0	0	0	0	0	0	0	0	0
Crustacea,	0	0	0	0	0	0	0	.04	0	0	0	0
Bosmina,	0	0	0	0	0	0	0	.02	0	0	0	0
Cyclops,	0	0	0	0	0	0	0	.02	0	0	0	0
Miscellaneous, Zoöglœa,	0	5	3	50	0	18	0	0	0	0	0	0
TOTAL,	0	909	1,369	55	0	54	156	6	22	120	20	10

Volume of Water flowing in the Merrimack River at Lawrence on the Dates when Samples of Water were collected for Analysis.

DATE.	VOLUME FLOWING IN THE MERRIMACK RIVER, IN CUBIC FEET PER SECOND.		DATE.	VOLUME FLOWING IN THE MERRIMACK RIVER, IN CUBIC FEET PER SECOND.	
	Rate of Flow during Eleven Hours of the Day.	Rate of Flow during Twenty-four Hours.		Rate of Flow during Eleven Hours of the Day.	Rate of Flow during Twenty-four Hours.
1896.			**1896** — Con.		
Jan. 22,	5,430	3,830	July 22,	3,097	2,077
Feb. 19,	9,670	7,140	Aug. 19,	3,250	1,990
March 18,	11,890	9,730	Sept. 16,	6,063	3,444
April 22,	22,680	20,900	Oct. 21,	6,884	5,386
May 20,	4,010	2,690	Nov. 18,	6,756	4,640
June 17,	6,320	3,750	Dec. 16,	6,481	4,736

LEICESTER.

Water Supply of Leicester Water Supply District, Leicester.

Chemical Examination of Water from the Wells of the Leicester Water Supply District.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15806	Jan. 20	V. slight.	V. slight.	.09	4.70	.0006	.0016	.29	.0730	.0000	.07	2.2	.0020
16234	Mar. 16	None.	None.	.07	4.90	.0002	.0030	.26	.0520	.0000	.06	1.8	[illegible]
16613	May 18	None.	None.	.12	4.60	.0000	.0006	.20	.0550	.0000	.07	1.7	.0030
17093	July 30	None.	None.	.00	4.80	.0000	.0014	.26	.0620	.0000	.03	2.0	.0030
17972	Dec. 1	None.	None.	.06	5.00	.0000	.0006	.29	.0600	.0000	.11	1.6	.0070

Averages by Years.

-	1892	-	-	.10	5.57	.0004	.0041	.23	.0736	.0001	-	2.4	.0243
-	1893	-	-	.28	5.25	.0002	.0032	.19	.0492	.0003	.16	2.1	.0420
-	1894	-	-	.10	6.49	.0001	.0019	.22	.0513	[illegible]	.11	2.5	.0143
-	1895	-	-	.43	5.65	.0002	.0091	.21	.0457	.0001	.47	2.2	.0087
-	1896	-	-	.06	4.80	.0002	.0014	.26	.0646	.0000	.07	1.9	.0040

Note to analyses of 1896. Odor of Nos. 16613 and 17972, vegetable or earthy; of the others, none. —The samples were collected from a faucet in the village.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

LEICESTER.

Chemical Examination of Water from One of the Wells of the Leicester Water Supply District.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
17491	[illegible] Sept. 16	Slight.	Slight.	2.00	12.50	.0116	.0436	.07	.0090	.0001	2.67	6.3	.0750

Odor, vegetable or earthy. —— The sample was collected from the south well in the Pierce Meadow. Water has not been drawn from this well recently.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

Chemical Examination of Water from an Underdrain beneath the Sewers at Leicester.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
19330	1896. Dec. 31	V. slight.	Slight.	.00	17.00	.0254	.0030	2.40	.0700	.0012	.06	4.6	.0080

Odor, none, becoming distinctly earthy on heating. —— The sample was collected from the underdrain in Pine Street.

Water Supply of Leominster.

During the year 1896 the sources of water supply of the town of Leominster were increased by the taking of the water of Fall Brook and the construction of a storage reservoir upon this stream in the southerly portion of the town.

The reservoir, when full, has an area of 82.5 acres, a capacity of about 386,000,000 gallons, an average depth of 14.3 feet and a maximum depth of 28 feet. The area flowed consisted chiefly of pasture and wood land, though a portion was under cultivation. In the lower portion of the valley there was a considerable area of meadow and swamp land, where the mud was found to extend to a considerable depth. The reservoir was prepared by the removal of all the stumps, soil and vegetable matter from the area flowed, with

the exception of about 19.5 acres of the swamp and meadow land in the lower portion of the area where the mud was quite deep, which was covered with gravel to a depth of from 15 to 18 inches after the removal of the trees and bushes. Storage in this reservoir was begun in the latter part of October.

The watershed of the reservoir has an area of 1.26 square miles and contains a very small population. The slopes are steep and there is very little swamp land on the area.

Chemical Examination of Water from Haynes Reservoir, Leominster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1896.														
15052	Jan. 27	Decided, green.	Slight.	.35	2.80	1.45	.0202	.0318	.0276	.0042	.17	.0150	.0001	.55	0.3
16299	Mar. 23	Decided, green.	V. slight.	.20	2.15	1.05	.0004	.0226	.0148	.0078	.17	.0050	.0000	.40	0.3
16670	May 24	Decided, yellow.	Cons., yellow.	.35	2.20	1.35	.0020	.0286	.0182	.0104	.12	.0060	.0000	.44	0.5
17084	July 27	Decided, green.	Cons., green.	.35	2.80	1.75	.0004	.0404	.0342	.0062	.17	.0030	.0000	.55	0.2
17428	Sept. 21	Decided, green.	Cons.	.33	2.35	1.50	.0000	.0486	.0286	.0200	.15	.0030	.0001	.53	0.1
17963	Nov. 25	Distinct.	Slight, green.	.25	3.10	1.65	.0112	.0384	.0322	.0062	.18	.0040	.0001	.46	0.2

Averages by Years.

-	1887*	-	-	.58	3.61	2.00	.0040	.0647	-	-	.13	.0084	-	-	-
-	1888	-	-	.36	2.80	1.42	.0023	.0352	-	-	.12	.0075	.0001	-	-
-	1889	-	-	.26	2.35	0.94	.0008	.0400	.0238	.0162	.11	.0034	.0001	-	-
-	[illegible]	-	-	.21	2.66	1.66	.0003	.0500	.0230	.0290	.11	.0063	.0001	-	0.6
-	1891	-	-	.24	2.80	1.48	.0005	.0482	.0231	.0251	.10	.0097	.0001	-	0.2
-	1893	-	-	.32	2.98	1.72	.0050	.0462	.0244	.0216	.14	.0028	.0003	.50	0.4
-	1894	-	-	.28	3.02	1.79	.0102	.0347	.0214	.0133	.15	.0020	.0001	.46	0.3
-	1895	-	-	.29	3.01	1.57	.0160	.0458	.0217	.0241	.18	.0023	.0000	.43	0.4
-	1896	-	-	.30	2.57	1.46	.0067	.0351	.0256	.0095	.16	.0062	.0000	.49	0.3

* June to December.

Note to analyses of 1896: Odor, vegetable or sweetish; in July, also unpleasant. A sweet, grassy odor was developed in most of the samples on heating.——The samples were collected from the reservoir.

LEOMINSTER.

Microscopical Examination of Water from Haynes Reservoir, Leominster.

[Number of organisms per cubic centimeter.]

	1896.					
	Jan.	Mar.	May.	July.	Sept.	Nov.
Day of examination,	28	24	27	28	22	27
Number of sample,	15952	16299	16670	17064	17523	17963
PLANTS.						
Diatomaceæ,	176	16	1,386	204	426	916
Asterionella,	0	0	40	172	52	56
Cocconeis,	0	0	0	0	0	4
Diatoma,	0	0	0	0	46	0
Melosira,	0	0	332	4	128	156
Navicula,	0	0	0	0	8	0
Nitzschia,	0	0	0	0	0	4
Synedra,	176	16	2	4	36	16
Tabellaria,	0	0	1,012	24	156	680
Cyanophyceæ,	0	0	0	190	76	7
Anabæna,	0	0	0	4	0	0
Clathrocystis,	0	0	0	0	4	6
Cœlosphærium,	0	0	0	184	40	1
Merismopedia,	0	0	0	0	30	0
Microcystis,	0	0	0	2	2	0
Algæ,	1	60	236	111	1,132	85
Botrycoccus,	0	0	0	0	0	32
Chlorococcus,	1	0	0	0	0	4
Cœlastrum,	0	0	0	0	412	0
Conferva,	0	0	0	10	0	0
Pediastrum,	0	0	24	28	24	4
Protococcus,	0	0	0	0	452	8
Raphidium,	0	0	120	8	0	0
Scenedesmus,	0	0	64	48	36	20
Selenastrum,	0	0	0	10	0	0
Staurastrum,	0	0	28	7	192	1
Staurogenia,	0	0	0	0	16	16
Zoöspores,	0	60	0	0	0	0
ANIMALS.						
Rhizopoda, Difflugia,	0	0	0	0	0	4
Infusoria,	4	16	2	4	1	868
Dinobryon,	0	0	0	2	0	868
Euglena,	0	0	1	0	0	0
Peridinium,	4	16	0	0	0	0
Tintinnidium,	0	0	0	2	0	0
Trachelomonas,	0	0	1	0	0	0
Uroglena,	0	0	0	0	1	0
Vermes,	0	1	2	2	2	10
Anurea,	0	1	1	2	2	4
Polyarthra,	0	0	0	0	0	4
Rotifer,	0	0	1	0	0	2
Crustacea, Cyclops,	.12	0	0	.04	.30	0
Miscellaneous, Zoöglœa,	0	3	80	80	100	60
TOTAL,	181	96	1,706	571	1,737	1,950

LEOMINSTER.

Chemical Examination of Water from Morse Reservoir, Leominster

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16053	Jan. 27	Slight.	Slight.	.30	2.50	1.15	.0034	.0130	.0110	[redacted]	.16	.0050	.0000	.41	0.6
16398	Mar. 23	Decided.	Slight.	.24	2.50	1.10	.0028	.0212	.0160	.0052	.14	.0060	.0000	.36	0.2
16660	May 24	Slight.	Cons.	.22	1.65	0.95	.0002	.0175	[redacted]	.0064	.14	.0030	.0000	.25	0.2
17063	July 27	Distinct.	Cons.	.22	2.60	1.45	.0004	.0332	.0242	.0090	.18	[redacted]	.0000	.45	0.2
17522	Sept. 21	Decided.	Slight.	.33	2.65	1.55	.0000	.0314	.0222	.0092	.16	[redacted]	.0001	.42	0.2
17964	Nov. 25	Distinct.	Slight.	[redacted]	3.10	1.30	.0004	.0202	.0172	.0030	.20	.0080	.0000	.47	0.5

Averages by Years.

-	1887*	-	-	.32	2.57	0.74	.0010	.0117	-	-	.12	.0028	-	-	-
-	1888†	-	-	.18	1.98	0.58	.0001	.0065	-	-	.09	.0036	.0000	-	-
-	1893	-	-	.40	2.73	1.36	.0009	.0175	.0135	.0040	.16	.0032	.0001	.62	0.5
-	1894	-	-	.36	2.50	1.11	.0026	.0169	.0128	.0041	.17	.0017	.0001	.41	0.2
-	1895	-	-	.26	2.80	1.40	.0107	.0269	.0213	.0055	.18	.0040	.0000	.45	0.3
-	1896	-	-	.28	2.53	1.25	.0012	.0228	.0173	.0055	.16	.0038	.0000	.39	0.3

* June to December. † February to May.

NOTE to analyses of 1896: Odor, vegetable. —— The samples were collected from the reservoir. Water from Haynes Reservoir has been diverted into Morse Reservoir since 1894.

LEOMINSTER.

Microscopical Examination of Water from Morse Reservoir, Leominster.

[Number of organisms per cubic centimeter.]

	1896.					
	Jan.	Mar.	May.	July.	Sept.	Nov.
Day of examination,	28	24	27	28	22	27
Number of sample,	15953	16298	16669	17063	17522	17964
PLANTS.						
Diatomaceæ,	4	160	225	15	73	16
Asterionella,	0	0	29	10	5	0
Fragilaria,	0	0	0	4	0	0
Melosira,	2	0	0	0	50	8
Navicula,	0	0	0	1	2	0
Nitzschia,	0	0	0	1	0	4
Synedra,	2	160	84	0	16	2
Tabellaria,	0	0	112	0	0	2
Cyanophyceæ, Merismopedia,	0	0	0	0	8	0
Algæ,	0	6	4	17	280	2
Arthrodesmus,	0	1	0	0	2	0
Botryococcus,	0	0	0	6	0	0
Cœlastrum,	0	0	0	0	28	0
Pandorina,	0	0	0	0	48	0
Protococcus,	0	0	0	0	138	0
Raphidium,	0	1	4	10	0	0
Scenedesmus,	0	4	0	0	2	0
Selenastrum,	0	0	0	0	32	0
Staurastrum,	0	0	0	1	22	2
Staurogenia,	0	0	0	0	8	0
ANIMALS.						
Rhizopoda, Actinophrys,	1	4	0	0	0	0
Infusoria,	8	3	160	12	0	20
Ciliated infusorian,	0	0	0	0	0	2
Dinobryon,	0	0	160	12	0	2
Euglena,	3	3	0	0	0	0
Mallomonas,	1	0	0	0	0	0
Monas,	3	0	0	0	0	0
Peridinium,	1	0	0	0	0	0
Tintinnidium,	0	0	0	0	0	2
Uroglena,	0	0	0	0	0	14
Vermes,	1	1	0	0	0	3
Anuræa,	0	1	0	0	0	0
Asplanchna,	0	0	0	0	0	1
Polyarthra,	1	0	0	0	0	2
Miscellaneous, Zoöglœa,	5	0	20	0	5	20
TOTAL,	19	174	409	45	366	61

Water Supply of Lexington.

Chemical Examination of Water from Vine Brook, above the Storage Reservoir of the Lexington Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1896.														
16393	Apr. 12	Slight.	Slight.	.22	3.30	1.30	.0000	.0066	.0054	.0012	.29	.0030	.0000	.21	0.5
16502	June 15	V. slight.	V. slight.	.50	5.15	1.55	.0026	.0138	.0138	.0000	.35	.0100	.0001	.67	1.2
17210	Aug. 17	Slight.	Slight.	.40	4.60	1.60	.0012	.0296	.0276	.0020	.40	.0000	.0000	.46	1.4
17524	Sept. 21	None.	Slight.	.40	7.55	2.30	.0002	.0166	.0154	.0012	.43	.0300	.0001	.56	2.5
17638	Oct. 13	Distinct.	Cons.	.30	8.50	2.55	[illegible]	.0186	.0136	.0050	.64	.0400	.0002	.48	2.1
17873	Nov. 17	None.	None.	.20	5.95	1.80	.0010	.0112	.0100	.0012	.51	.0200	.0001	.32	2.6
18160	Dec. 21	V. slight.	Slight.	.12	5.25	1.30	.0010	.0076	.0066	.0010	.50	.0250	.0000	.27	1.8
Av.		....	....	.30	5.51	1.77	.0009	.0149	.0132	.0017	.45	.0183	.0001	.48	1.7

Odor, generally distinctly vegetable; in April, mouldy. —— The samples were collected from the brook, at entrance to storage reservoir.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 81.

Chemical Examination of Water from the Vine Brook Storage Reservoir of the Lexington Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1896.														
15901	Jan. 20	Slight.	Slight.	0.35	6.35	2.15	.0010	.0236	.0190	.0046	.50	.0700	.0002	.49	2.2
16299	Mar. 18	Distinct.	V. slight.	0.30	4.90	1.45	.0008	.0288	.0204	.0084	.42	.0200	.0004	.42	2.0
16394	Apr. 12	Slight.	Slight.	0.22	4.50	1.85	.0000	.0214	.0168	.0046	.33	.0180	.0006	.36	1.1
16632	May 20	Distinct, clayey.	Slight.	0.23	4.10	1.85	.0008	.0230	.0162	.0068	.41	.0070	.0001	.32	1.6
16633	May 20	Distinct, clayey.	Slight.	0.23	4.15	1.65	.0008	.0226	.0192	.0034	.41	.0130	.0002	.32	1.3
16803	June 16	Decided, green.	Cons., green.	0.37	4.30	1.30	.0020	.0342	.0246	.0096	.42	.0000	.0000	.52	1.4
16975	July 14	Distinct.	Slight, green.	0.40	4.80	1.70	.0026	.0242	.0222	.0020	.45	.0000	.0002	–	1.3
17211	Aug. 17	Slight.	Slight.	0.37	4.35	1.55	.0000	.0270	.0248	.0022	.41	.0000	.0000	.42	1.4
17525	Sept. 21	V. slight.	V. slight.	0.35	4.40	2.30	.0006	.0270	.0232	.0038	.39	.0030	.0001	.44	1.4
17639	Oct. 13	Slight.	Slight.	0.28	4.05	1.50	.0012	.0212	.0192	.0020	.45	.0070	.0001	.39	1.8
17874	Nov. 17	Slight.	Slight.	0.33	4.65	1.40	.0006	.0198	.0186	.0012	.48	.0180	.0001	.35	1.4
18161	Dec. 21	V. slight.	Slight.	0.12	4.85	1.30	.0006	.0078	.0066	.0012	.48	.0380	.0000	.22	1.9
Av.	1896*	....	....	0.30	4.66	1.65	.0009	.0234	.0194	.0040	.43	.0167	.0002	.39	1.6
Av.	1895†	....	....	0.41	6.66	2.17	.0012	.0234	.0187	.0047	.52	.0409	.0003	.65	2.6

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

† May to December.

Note to analyses of 1896: Odor, vegetable, becoming somewhat stronger on heating. —— The samples were collected from the reservoir.

LEXINGTON.

Microscopical Examination of Water from the Vine Brook Storage Reservoir of the Lexington Water Works.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Mar	Apr.	May	May.	June.	July.	Aug	Sept	Oct.	Nov	Dec.
Day of examination,	21	20	14	21	21	17	15	18	22	15	15	22
Number of sample,	15901	16289	16394	16632	16633	16808	16975	17211	17525	17639	17874	18161
PLANTS.												
Diatomaceæ,	0	0	20	20	20	10	4	0	16	32	6	15
Meridion,	0	0	0	0	0	0	0	0	0	0	0	12
Navicula,	0	0	7	0	0	3	4	0	0	4	0	1
Synedra,	0	0	13	20	20	7	0	0	16	28	6	2
Cyanophyceæ,	0	0	0	0	0	1	14	17	0	0	0	[illegible]
Clathrocystis,	0	0	0	0	0	1	0	17	0	0	0	0
Cœlosphærium,	0	0	0	0	0	0	14	0	0	0	0	0
Algæ,	302	124	9	144	144	205	724	127	12	4	3	1
Protococcus,	300	124	0	144	144	160	560	120	12	4	3	1
Cœlastrum,	0	0	0	0	0	20	124	0	0	0	0	0
Raphidium,	2	0	9	0	0	2	0	0	0	0	0	0
Scenedesmus,	0	0	0	0	0	1	2	7	0	0	0	0
Selenastrum,	0	0	0	0	0	20	0	0	0	0	0	0
Staurogenia,	0	0	0	0	0	2	38	0	0	0	0	0
ANIMALS.												
Infusoria,	4	5	3	2	1	0	0	0	pr.	0	2	0
Ciliated infusorian,	0	2	0	0	0	0	0	0	0	0	0	0
Dinobryon,	0	0	0	0	0	0	0	0	0	0	2	0
Peridinium,	4	3	3	0	0	0	0	0	0	0	0	0
Trachelomonas,	0	0	0	2	1	0	0	0	pr.	0	0	0
Vermes, Polyarthra,	0	0	0	0	0	0	0	0	2	4	0	0
Crustacea, Cyclops,	0	0	0	0	0	0	.02	0	0	0	0	0
Miscellaneous, Zoöglœa,	5	0	0	6	5	40	5	0	50	20	0	0
TOTAL,	311	129	32	172	170	256	747	144	80	60	11	16

LEXINGTON.

Chemical Examination of Water from a Faucet in Lexington, supplied from the Lexington Water Works.

[Parts per 100,000.]

Number	Date of Collection	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended		Nitrates.	Nitrites.		
16976	1896. July 14	V. slight.	Slight.	.18	7.30	1.40	.0000	.0056	.0042	.0014	.52	.0400	.0002	–	4.0

Odor, none, becoming distinctly vegetable and faintly unpleasant when heated. —— The sample was collected from a faucet in the town.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

Water Supply of Lincoln.

(See *Concord.*)

Water Supply of Longmeadow.

Chemical Examination of Water from Cooley Brook, Longmeadow.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended		Nitrates	Nitrites		
15965	1896. Jan. 28	V. slight.	V. slight.	.05	4.70	0.70	.0000	.0024	.0018	.0006	.17	.0400	.0000	.11	2.9
16302	Mar. 23	Slight.	Slight.	.12	3.30	-	.0000	.0110	–	-	.17	.0300	.0000	.15	2.0
16665	May 25	None.	V. slight.	.10	4.70	1.20	.0002	.0042	.0032	.0010	.17	.0400	.0000	.02	3.0
17100	July 29	None	V. slight	.07	5.05	1.15	.0006	.0024	.0018	.0006	.13	.0300	.0001	.08	3.0
17564	Sept. 28	Slight.	Slight.	.04	5.30	0.80	.0022	.0038	.0030	.0008	18	.0330	.0000	.12	2.8
17962	Nov. 24	V. slight.	V. slight.	.07	5.55	1.35	.0004	.0022	.0018	.0004	.20	.0550	.0000	[illegible]	3.0
Av.	....	....	....	.07	5.06	1.04	.0006	.0030	.0023	.0007	.17	.0380	.0000	.09	2.8

Odor of the last sample, distinctly unpleasant; of the others, none. —— The first three samples were collected from faucets in the town, and the others from a faucet at the pumping station while pumping.

Microscopical Examination.

No organisms were found in Nos. 16302 and 17564; an insignificant number was found in the others.

LOWELL.

WATER SUPPLY OF LOWELL.

A third system of tubular wells for supplying water to the city of Lowell was completed during the year 1896. The wells are located on the north bank of the Merrimack River, between the river and the Pawtucket Boulevard, about a quarter of a mile above the Lowell dam. The system consists of 169 two and one-half inch wells, varying in depth from 27 to 40 feet, and situated at a distance of from 150 to 350 feet from the bank of the river. Pumping from this plant was begun Feb. 28, 1896. The tubular wells are said to have furnished all the water supplied to the city from Feb. 22, 1896, to the end of the year.

Chemical Examination of Water from the Merrimack River above Lowell.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Sus-pended.					
	1896.														
15916	Jan. 21	Distinct.	Slight.	.30	3.60	1.60	.0028	.0140	.0126	.0014	.16	.0120	.0000	.42	1.4
16069	Feb. 18	Slight.	Slight.	.40	3.05	1.00	.0018	.0146	.0134	.0012	.14	.0060	.0000	.56	0.8
16262	Mar. 17	Distinct.	Slight.	.33	2.60	1.00	.0016	.0132	.0100	.0032	.15	.0100	.0000	.43	1.1
16449	Apr 21	Distinct	Cons	.40	2.80	1.00	.0002	.0178	.0134	.0044	.07	.0080	.0000	.48	0.6
16620	May 19	Distinct.	Slight, earthy	.28	2.85	1.20	.0016	.0152	.0126	.0026	.14	.0070	.0000	.42	1.0
16817	June 16	Distinct.	Slight.	.40	3.55	1.85	.0072	.0168	.0146	.0022	.11	.0050	.0001	.57	1.0
17020	July 21	Distinct, green.	Slight, green.	.23	3.60	1.20	.0066	.0208	.0154	.0054	.22	.0050	.0004	.29	1.3
17234	Aug. 18	Distinct.	Cons., green.	.28	3.70	1.40	.0026	.0186	.0138	.0048	.24	.0050	.0003	.34	0.8
17471	Sept. 15	Slight.	Cons.	.48	3.90	1.60	.0064	.0180	.0138	.0042	.18	.0020	.0001	.56	0.8
17676	Oct. 20	Slight.	Slight.	.75	4.45	1.70	.0040	.0200	.0188	.0012	.17	.0060	.0003	.95	1.0
17877	Nov 17	Slight.	Cons.	.50	3.70	1.30	.0024	.0146	.0130	.0016	.18	.0100	.0003	.59	1.2
18124	Dec. 15	Slight.	Cons.	.40	3.50	1.20	.0040	.0172	.0124	.0048	.23	.0070	.0001	.55	1.0

Averages by Years.

-	1887*	-	-	.44	4.29	1.16	.0021	.0158	-	-	.17	.0084	-	-	-
-	1888	-	-	.30	3.42	0.97	.0016	.0148	-	-	.16	.0099	.0002	-	-
-	1889	-	-	.28	2.95†	0.64†	.0018	.0149	.0126	.0023	.14	.0071	.0002	-	-
-	1890	-	-	.30	3.57‡	1.64‡	.0014	.0129	.0104	.0024	.13	.0111	.0001	-	1.4
-	1891	-	-	.29	3.43	1.23	.0017	.0129	.0100	.0029	.13	.0137	.0001	-	1.2
-	1892	-	-	.39	3.61	1.36	.0021	.0141	.0113	.0028	.14	.0092	.0001	-	1.3
-	1893	-	-	.33	3.32	1.18	.0026	.0149	.0120	.0029	.17	.0083	.0001	.44	1.1
-	1894	-	-	.35	3.55	1.26	.0034	.0135	.0109	.0026	.15	.0063	.0001	.40	1.1
-	1895	-	-	.41	3.84	1.46	.0039	.0187	.0140	.0047	.21	.0066	.0001	.54	1.2
-	1896	-	-	.40	3.47	1.28	.0034	.0167	.0136	.0031	.17	.0070	.0001	.52	1.0

* June to December. † January to May. ‡ September to December.

NOTE to analyses of 1896: Odor, generally distinctly vegetable and musty or mouldy, sometimes unpleasant or disagreeable. —— The samples were collected from the river, opposite the intake of the Lowell Water Works.

For a comparison of the analyses of the river at Lowell and Lawrence for a series of years, see "Merrimack River" in the chapter on "Examination of Rivers" in a subsequent portion of this report.

LOWELL.

Chemical Examination of Water from Tubular Wells in the Valley of River Meadow Brook, a Short Distance above Plain Street.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15916	Jan. 21	V. slight.	V. slight.	[redacted]	9.60	.0000	.0036	.44	.0420	.0001	.10	4.0	.0110
16090	Feb. 18	None.	[redacted]	.05	9.30	.0000	.0050	.49	.0470	.0000	.06	4.5	.0070
16268	Mar. 17	None.	Slight.	.02	8.40	.0006	.0024	.55	.0420	.0000	.08	3.5	.0060
16682	May 19	None.	None.	[redacted]	7.90	.0006	.0024	.50	.0350	.0000	.09	3.4	.0080
17679	Oct. 20	None.	None.	.03	7.50	.0002	.0018	.54	.0600	.0002	.09	3.3	.0070
18125	Dec. 15	None.	None.	.03	7.30	.0002	.0036	.55	.0580	.0000	.10	3.9	.0060

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1893*	-	-	.00	7.24	.0001	.0008	.46	.1030	.0001	.08	2.7	.0060
-	1894	-	-	.02	7.83	[redacted]	.0014	.55	.0640	.0002	.02	[redacted]	.0076
-	1895	-	-	.02	9.22	.0001	.0024	.56	.0323	.0002	.05	3.8	.0119
-	1896	-	-	.02	8.37	.0002	.0035	.53	.0507	[redacted]	.09	3.8	.0068

* June to December.

NOTE to analyses of 1896: Odor, none. —— The samples were collected from the wells, which are locally known as the "Cook" wells. No water was drawn from these wells from June 1 to October 9.

Microscopical Examination.

No. 18125. Fungi, *Crenothrix*, 50.
No organisms were found in the remaining samples.

LOWELL.

Chemical Examination of Water from Tubular Wells in the Valley of River Meadow Brook, a Short Distance above the Old Middlesex Canal in Chelmsford.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15551	Jan. 7	Slight, rusty.	Slight, rusty.	.12	16.40	.0052	.0034	.29	.0080	.0000	.09	7.3	.0980
15917	Jan. 21	Distinct, rusty.	Slight, rusty	.02	15.30	.0054	.0044	.35	.0080	.0000	.10	7.1	.0980
16091	Feb. 18	Slight, rusty.	Cons., rusty.	.12	14.90	.0066	.0064	.32	.0080	.0000	.12	6.6	.0870
16264	Mar. 17	None.	Slight.	.10	12.10	.0068	.0084	.35	.0070	.0000	.13	5.1	.0700
16450	Apr. 21	Slight.	Slight.	.12	10.10	.0066	.0048	.23	.0100	.0000	.11	4.6	.0690
16621	May 19	Decided, rusty	Cons., rusty.	.04	10.50	.0068	.0062	.31	.0050	[redacted]	.13	4.6	.2400
16818	June 16	None.	V. slight.	.13	9.60	.0054	.0046	.34	.0040	[redacted]	.14	4.2	.0040
17027	July 21	Slight, clayey.	Slight.	.13	10.00	.0064	.0046	.34	.0070	.0000	.12	4.8	.0300
17235	Aug. 18	Slight, milky.	Slight.	.10	9.80	.0058	[redacted]	.32	.0050	.0000	.16	4.2	.0450
17464	Sept. 15	Distinct.	Slight.	.12	10.60	.0069	.0048	.34	.0070	.0000	.13	4.6	.0400
17678	Oct. 20	V. slight.	Slight.	.10	10.80	.0070	.0056	.32	.0070	.0005	.14	4.9	.0690
17879	Nov. 17	Slight.	Cons.	.10	[redacted]	.0080	.0044	.38	.0100	.0002	.18	5.1	.0420
Av....	1896*	....	....	.10	11.50	.0064	.0047	.32	.0071	.0001	.13	5.6	.0697
Av....	1895	....	....	.12	9.42	.0020	.0017	.31	.0073	.0000	.05	3.9	.0673

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1896. Odor, faintly vegetable or none. —— The samples were collected from a faucet at the pumping station, while pumping. These wells are locally known as the "Hydraulic Construction Company's" wells.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 146, consisting chiefly of *Crenothrix*.

LOWELL.

Chemical Examination of Water from Tubular Wells in the Valley of the Merrimack River near the Pawtucket Boulevard.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16371	Apr 7	None.	None.	.00	6.80	.0004	.0004	.56	.1800	.0000	.02	2.6	.0030
16623	May 19	None.	None.	.00	4.00	.0020	.0018	.31	.0600	.0000	.02	2.0	.0020
16819	June 16	None.	None.	.00	3.80	.0014	.0012	.26	.0810	.0000	.02	1.6	.0030
17028	July 21	None.	Slight, white.	.08	4.70	.0074	.0022	.23	.0280	.0000	.04	1.7	.0100
17236	Aug. 18	None.	Slight.	.02	3.70	.0056	.0018	.24	.0150	.0001	.04	1.4	.0030
17472	Sept. 15	V. slight.	Slight, rusty.	.01	4.60	.0068	.0024	.26	.0190	[illegible]	.08	1.7	.0140
17677	Oct. 20	None.	V. slight.	.02	3.70	.0056	.0024	.26	.0200	.0008	.07	1.6	.0160
17878	Nov. 17	None.	Slight.	.02	4.40	.0050	.0012	.29	.0270	.0001	.09	1.8	.0150
18126	Dec. 15	None.	Slight, rusty.	.08	3.60	.0064	.0038	.26	.0800	.0001	.04	2.2	.0220
Av.	....	....	....	.01	4.36	.0044	.0019	.30	.0452	.0001	.04	1.8	.0096

Odor, none. —— The samples were collected from a faucet at the pumping station, while pumping. The wells are locally known as the "Boulevard" wells.

Microscopical Examination.

An insignificant number of organisms was found in Nos. 17236 and 17472; no organisms were found in the other samples.

Water Supply of Ludlow.

(See *Springfield.*)

Water Supply of Lynn and Saugus.

During 1896 the capacity of the works for supplying water to the city of Lynn was increased by the completion of a storage reservoir upon Hawkes Brook. This reservoir has an area of 75 acres, a maximum depth of 25 feet and an average depth of 12.3 feet. Its capacity is about 300,000,000 gallons. The reservoir was prepared for the storage of water by the removal of stumps, soil and vegetable matter over a large portion of its area, but over a considerable portion of the area, on account of the depth of the mud, this material was not removed, but these areas are said to have been covered with gravel to a depth of about 18 inches.

The area of the watershed, including the reservoir, is about 1.9 square miles and contains a small population.

LYNN AND SAUGUS.

Chemical Examination of Water from Breed's Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
15880	[redacted] Jan. 14	Slight.	Slight.	.63	3.95	1.80	.0072	.0188	.0160	.0028	.51	.0030	.0001	.67	[illegible]
16044	Feb. 11	V. slight.	Slight.	.50	3.50	1.80	.0038	.0136	.0116	.0020	.44	.0070	.0001	.58	0.5
16216	Mar. 10	Slight.	Slight.	.70	3.65	1.30	.0026	.0166	.0144	.[redacted]	.49	.0050	.0000	.58	1.0
16405	Apr. 14	Slight.	Slight.	.38	3.60	1.35	.0002	.0128	.0108	.0020	.40	.0030	.0000	.44	0.5
16581	May 12	Distinct.	Slight.	.40	3.25	1.40	.0014	.0176	.0120	.0056	.53	.0000	.0001	.41	0.3
16751	June 9	Slight.	Slight.	.35	3.45	1.30	.0016	.0214	.0196	.0018	.46	.0030	.[redacted]	.48	0.6
16978	July 14	V. slight.	Cons., brown.	.32	3.75	1.35	.0000	.0170	.0152	.0018	.54	.0000	.0001	–	0.7
17169	Aug. 11	Slight.	Slight.	.25	3.25	1.15	.0018	.0192	.0142	.0050	.56	.0000	.0001	.41	0.6
17380	Sept. 8	Slight.	Slight.	.27	3.85	1.30	.0018	.0194	.0174	.0020	.58	.0000	.0001	.34	0.9
17598	Oct. 7	Slight.	Slight.	.22	3.30	1.10	.0016	.0224	.0178	.0046	.57	.0000	.0001	.41	0.8
17828	Nov. 10	Slight.	Slight.	.33	3.25	1.30	.0026	.0188	.0166	.0022	.59	.0020	.0001	.37	0.8
18035	Dec. 8	Slight.	Slight.	.38	3.85	1.50	.0060	.0198	.0164	.0034	.60	.0000	.0001	.50	0.6

Averages by Years.

–	1887*	–	–	.51	3.70	1.32	.0006	.0217	–	–	.44	.0084	–	–	–
–	1888	–	–	.46	3.71	1.43	.0029	.0227	–	–	.45	.0068	.0002	–	–
–	1889	–	–	.45	3.09	1.02	.0007	.0208	.0165	.0043	.41	.0085	.0001	–	–
–	1890	–	–	.42	3.62	1.51	.0014	.0196	.0155	.0041	.41	.0052	.0001	–	1.1
–	1891	–	–	.35	3.35	1.37	.0009	.0156	.0131	.0026	.40	.0060	.0001	–	0.8
–	1892	–	–	.43	[redacted]	1.38	.0004	.0220	.0177	.0043	.49	.[redacted]		–	1.0
–	1893	–	–	.65	3.61	1.41	.0039	.0214	.0181	.0033	.55	.0054	.0001	.51	1.1
–	1894	–	–	.63	3.77	1.47	.0023	.0225	.0191	.0034	.58	.0032	.0000	.53	0.9
–	1895	–	–	.48	3.75	1.48	.0016	.0199	.0171	.0028	.58	[redacted]		.50	0.9
–	1896	–	–	.39	3.57	1.36	.0022	.0181	.0152	.0029	.52	.0019	.0001	.47	0.7

* June to December.

Note to analyses of 1896 Odor, vegetable, occasionally none. —— The samples were collected from the pond, near the gate-house, about 1 foot beneath the surface. For monthly height of water in this pond, see page 219.

LYNN AND SAUGUS.

Microscopical Examination of Water from Breed's Pond, Lynn.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	16	13	11	15	13	10	15	12	9	8	12	10
Number of sample,	15860	16044	16226	16405	16581	16751	16976	17169	17380	17598	17826	18035
PLANTS.												
Diatomaceæ,	7	0	0	21	395	29	170	386	522	2	8	18
Asterionella,	7	0	0	14	392	4	46	90	200	0	8	12
Melosira,	0	0	0	0	0	0	0	0	8	0	0	0
Synedra,	0	0	0	6	1	0	0	4	2	0	0	5
Tabellaria,	0	0	0	1	2	25	124	292	252	2	0	1
Cyanophyceæ,	0	0	0	0	18	5	0	12	0	32	0	0
Anabæna,	0	0	0	0	18	0	0	10	0	32	0	0
Microcystis,	0	0	0	0	0	5	0	2	0	0	0	0
Algæ,	[illegible]	1	0	0	6	0	16	0	[illegible]	14	0	0
Protococcus,	0	0	0	0	6	0	0	0	2	14	0	0
Raphidium,	0	1	0	0	0	0	16	0	0	0	0	0
ANIMALS.												
Rhizopoda, Difflugia,	0	0	0	0	0	3	[illegible]	1	[illegible]	0	0	0
Infusoria,	56	[illegible]	5	2	38	33	12	6	46	6	8	7
Dinobryon,	51	2	0	0	1	0	8	0	44	0	0	0
Euglena,	0	0	0	0	0	0	2	0	0	0	0	0
Mallomonas,	1	0	1	1	5	0	0	0	0	2	1	5
Monas,	0	0	1	0	0	0	0	0	0	4	0	0
Peridinium,	4	2	3	0	0	1	2	4	0	0	2	1
Phacus,	0	0	0	0	16	32	0	0	0	0	0	0
Trachelomonas,	0	0	0	1	0	0	0	2	2	0	3	0
Vorticella,	0	0	0	0	16	0	0	0	0	0	0	0
Crustacea, Cyclops,	0	0	0	.02	0	0	[illegible]	0	0	0	0	0
Miscellaneous,	0	0	20	0	40	60	0	20	50	30	15	5
Acarina,	0	0	.08	0	.04	.02	0	0	.02	0	0	0
Zoöglœa,	0	0	20	0	40	60	0	20	50	30	15	5
TOTAL,	63	5	25	23	499	151	195	367	620	54	29	30

LYNN AND SAUGUS.

Chemical Examination of Water from Birch Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
15879	Jan. 14	Slight.	Slight.	.60	4.85	2.15	.0030	.0260	.0224	.0036	.55	.0100	.0001	.72	1.3
16043	Feb. 11	Slight.	Slight.	.68	4.65	2.05	.0034	.0214	.0182	.0032	.55	.0150	.0001	.68	1.1
16227	Mar. 10	Distinct.	Slight.	.58	4.75	1.95	.0030	.0234	.0214	.0020	.53	.0080	.0000	.59	1.6
16404	Apr. 14	Distinct.	Slight.	.38	4.00	1.50	.0010	.0188	.0160	.0028	.52	.0030	.0001	.48	0.6
16582	May 12	Distinct.	Slight.	.33	3.10	1.25	.0002	.0220	.0174	.0046	.58	.0030	.0000	.44	1.0
16752	June 9	Slight.	Slight.	.42	3.65	1.60	.0040	.0268	.0228	.0040	.50	.0030	.0001	.59	1.0
16977	July 14	Slight.	Slight.	.32	4.10	1.35	.0000	.0250	.0206	.0044	.62	.0000	.0000	-	1.0
17168	Aug. 11	Distinct.	Slight.	.35	4.00	1.30	.0008	.0248	.0224	.0024	.60	.0000	.0001	.48	1.0
17379	Sept. 8	Distinct.	Slight.	.37	4.50	1.45	.0012	.0262	.0248	.0014	.63	.0020	.0000	.37	1.3
17597	Oct. 7	V. slight.	Slight.	.34	3.80	1.35	.0034	.0230	.0206	.0024	.62	.0030	.0001	.44	0.9
17827	Nov. 10	Distinct.	Slight.	.53	4.70	2.05	.0008	.0298	.0240	.0058	.68	.0050	.0002	.61	1.0
18034	Dec. 8	Slight.	Slight.	.50	4.60	1.85	.0010	.0246	.0192	.0054	.62	.0050	.0000	.65	1.1

Averages by Years.

-	1887*	-	-	.57	4.02	1.61	.0016	.0289	-	-	.43	.0044	-	-	-
-	1888	-	-	.33	3.48	1.40	.0026	.0287	-	-	.45	.0082	.0001	-	-
-	1889	-	-	.23	2.96	1.14	.0014	.0241	.0190	.0051	.41	.0048	.0001	-	-
-	1890	-	-	.36	3.57	1.35	.0013	.0227	.0179	.0048	.42	.0088	.0001	-	1.0
-	1891	-	-	.42	3.26	1.30	.0005	.0241	.0183	.0058	.40	.0065	.0001	-	0.7
-	1892	-	-	.48	3.73	1.56	.0016	.0299	.0227	.0072	.47	.0092	.0001	-	1.0
-	1893	-	-	.75	4.21	1.63	.0052	.0299	.0218	.0081	.51	.0059	.0001	.53	1.0
-	1894	-	-	.75	4.47	1.88	.0053	.0292	.0242	.0050	.57	.0076	.0001	.63	1.1
-	1895	-	-	.60	5.05	2.12	.0031	.0294	.0222	.0072	.70	.0063	.0001	.62	1.4
-	1896	-	-	.45	4.22	1.65	.0018	.0243	.0208	.0035	.58	.0047	.0001	.55	1.1

* June to December.

NOTE to analyses of 1896: Odor, generally vegetable, sometimes also mouldy or grassy, rarely none. —— The samples were collected from the pond, near the gate-house, 1 foot beneath the surface. For monthly height of water in this pond, see page 219.

LYNN AND SAUGUS.

Microscopical Examination of Water from Birch Pond, Lynn.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan	Feb.	Mar.	Apr.	May.	June.	July.	Aug	Sept.	Oct.	Nov.	Dec.
Day of examination,	16	12	11	15	13	10	15	12	9	8	12	10
Number of sample,	15879	16048	16227	16404	16582	16752	16977	17168	17379	17597	17827	18084
PLANTS.												
Diatomaceæ,	149	244	252	580	2,819	36	788	66	96	104	87	73
Asterionella,	49	112	192	428	72	1	132	0	0	16	8	8
Cyclotella,	32	0	0	0	0	0	512	0	0	0	0	0
Diatoma,	0	0	0	0	3	0	0	0	0	6	0	0
Fragilaria,	0	0	0	0	0	0	0	0	0	14	0	0
Melosira,	0	0	0	0	0	0	0	0	0	4	4	0
Navicula,	0	0	0	4	0	0	0	0	0	0	3	0
Synedra,	64	128	40	148	2,700	0	0	0	0	16	60	64
Tabellaria,	4	4	20	0	44	35	144	66	96	48	12	1
Cyanophyceæ,	0	0	0	0	0	3	0	13	65	14	0	0
Anabæna,	0	0	0	0	0	0	0	13	60	14	0	0
Microcystis,	0	0	0	0	0	3	0	0	5	0	0	0
Algæ,	16	0	5	10	34	0	46	19	24	6	5	1
Botryococcus,	0	0	0	0	0	0	0	4	0	2	0	0
Chlorococcus,	6	0	0	0	0	0	0	0	0	0	0	0
Protococcus,	0	0	0	0	8	0	0	2	4	2	0	1
Raphidium,	10	0	5	10	25	0	42	5	11	0	5	0
Staurastrum,	0	0	0	0	1	0	4	8	9	2	0	0
Fungi, Crenothrix,	0	1	0	5	0	0	0	0	0	0	0	0
ANIMALS.												
Rhizopoda, Actinophrys,	1	0	0	0	0	0	[illegible]	0	0	0	4	0
Infusoria,	18	8	26	29	6,800	9	46	501	17	10	44	8
Dinobryon,	9	7	24	22	6,800	0	44	500	9	6	24	0
Mallomonas,	5	0	0	0	0	1	0	0	2	0	0	0
Peridinium,	3	1	2	5	0	1	0	1	1	2	4	5
Phacus,	0	0	0	0	0	7	0	0	0	0	0	0
Trachelomonas,	1	0	0	2	0	0	2	0	6	2	16	3
Vermes,	2	0	0	10	1	1	0	0	1	[illegible]	1	0
Anuræa,	0	0	0	9	0	0	0	0	1	0	0	0
Asplanchna,	0	0	0	1	0	0	0	0	0	0	1	0
Rotatorian ova,	2	0	0	0	0	0	0	0	0	0	0	0
Rotifer,	0	0	0	0	1	1	0	0	0	0	0	0
Crustacea, Daphnia,	.02	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous,	0	40	40	0	20	10	10	20	60	20	20	10
Acarina,	.06	.10	.02	0	0	0	.04	0	0	0	0	0
Zoöglœa,	0	40	40	0	20	10	10	20	60	20	20	10
TOTAL,	188	293	323	634	9,674	59	890	619	263	154	166	112

LYNN AND SAUGUS.

Chemical Examination of Water from Walden Pond, Lynn.

[Parts per 100,000.]

Number	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16229	Mar. 10	Distinct.	Slight.	0.50	3.30	1.45	.0008	.0244	.0190	.0054	.35	.0030	.0000	0.49	0.6
16407	Apr. 14	Distinct.	Slight.	0.38	2.95	1.20	.0000	.0186	.0164	.0022	.34	.0020	.0000	0.44	0.3
16584	May 12	Distinct.	Slight.	0.38	3.05	1.16	.0025	.0220	.0194	.0026	.44	.0020	.0000	0.44	0.5
16754	June 9	Distinct, green.	Slight, green.	0.60	3.10	1.35	.0106	.0312	.0288	.0024	.38	.0030	.0001	0.71	0.7
16960	July 14	Distinct.	Slight, green.	1.00	3.95	1.90	.0004	.0346	.0292	.0054	.43	.0000	.0001	1.30	0.6
17171	Aug. 11	Distinct.	Cons.	1.25	4.35	2.40	.0042	.0468	.0404	.0064	.44	.0000	.0000	1.16	0.6

Averages by Years.

Number	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1890	-	-	1.06	4.95	2.55	.0292	.0432	.0351	.0081	.34	.0067	.0001	-	1.1
-	1891	-	-	1.21	4.32	2.20	.0058	.0615	.0403	.0212	.34	.0091	.0001	-	0.7
-	1892	-	-	0.90	4.61	[illegible]	.0094	.0626	.0383	.0243	.41	.0116	.0001	-	0.6
-	[illegible]	-	-	0.92	4.33	2.40	.0066	.0470	.0309	.0161	.44	.0047	.0001	0.80	0.7
-	1894*	-	-	0.94	3.95	[illegible]	.0056	.0346	.0240	.0106	.47	.0015	.0000	0.79	0.5
-	1895†	-	-	0.91	[illegible]	2.02	.0125	.0368	.0262	.0106	.51	.0043	.0001	0.74	0.7
-	1896	-	-	0.08	3.45	1.57	.0031	.0296	.0255	.0041	.40	.0017	.0000	0.76	0.5

* January to June. † May, June and July.

Note to analyses of 1896: Odor, distinctly vegetable and sometimes mouldy or grassy. —— The samples were collected from the pond, near the gate-house, 1 foot beneath the surface. For monthly height of water in this pond, see page 219.

LYNN AND SAUGUS.

Microscopical Examination of Water from Walden Pond, Lynn.

[Number of organisms per cubic centimeter.]

	1896.					
	Mar	Apr.	May.	June.	July.	Aug.
Day of examination,	11	15	13	10	15	12
Number of sample,	16229	16407	16584	16754	16960	17171
PLANTS.						
Diatomaceæ,	120	850	100	1	14	3
Asterionella,	116	816	96	0	6	2
Synedra,	0	2	0	1	0	1
Tabellaria,	4	32	4	0	8	0
Cyanophyceæ, Clathrocystis,	0	0	0	0	0	[illegible]
Algæ,	1	1	37	64	0	219
Arthrodesmus,	0	0	28	0	0	0
Protococcus,	1	0	4	64	0	212
Raphidium,	0	1	4	0	0	0
Staurastrum,	0	0	1	0	0	7
ANIMALS.						
Rhizopoda, Arcella,	0	2	0	0	0	0
Infusoria,	70	321	12	0	76	1
Dinobryon,	33	228	9	0	0	0
Dinobryon cases,	0	32	0	0	0	0
Euglena,	0	1	0	0	76	0
Peridinium,	36	60	0	0	0	0
Raphidomonas,	0	0	0	0	0	1
Trachelomonas,	1	0	0	0	0	0
Uroglena,	0	0	3	0	0	0
Vermes,	0	0	0	1	0	4
Anguillula,	0	0	0	1	0	0
Asplanchna,	0	0	0	0	0	1
Polyarthra,	0	0	0	0	0	3
Crustacea,	0	0	.06	0	0	0
Bosmina,	0	0	.02	0	0	0
Cyclops,	0	0	.04	0	0	0
Miscellaneous,	5	40	80	10	5	80
Acarina,	0	.02	.02	0	0	.10
Zooglœa,	5	40	80	10	5	80
TOTAL,	196	1,214	229	76	95	312

LYNN AND SAUGUS.

Chemical Examination of Water from Glen Lewis Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15881	Jan. 14	Distinct.	Slight.	.33	3.55	1.86	.0118	.0250	.0222	.0028	.44	.0030	.0002	.45	0.2
16045	Feb. 11	Distinct.	Slight.	.30	3.15	1.65	.0034	.0152	.0130	.0022	.30	.0070	.0002	.44	0.2
16223	Mar. 10	Distinct.	V. slight.	.23	3.20	1.30	.0008	.0188	.0144	.0044	.40	.0020	.0001	.32	0.2
16406	Apr. 14	Distinct.	Slight.	.25	2.75	0.95	.0000	.0188	.0120	.0068	.37	.0020	.0000	.26	0.5
16583	May 12	Distinct.	Slight, green.	.28	2.70	1.40	.0084	.0260	.0162	.0098	.43	.0020	.0000	.52	0.2
16753	June 9	Distinct, green.	Slight, green.	.50	3.10	1.60	.0178	.0498	.0324	.0174	.42	.0050	.0001	.50	0.2
16979	July 14	Decided, green.	Cons.	.55	4.00	2.70	.0098	.2136	.0662	.1474	.38	.0000	.0001	.63	0.6
17170	Aug. 11	Decided, green	Cons., green.	.62	4.65	2.50	.0042	.0710	.0388	.0322	.47	.0030	.0000	.70	0.5
17381	Sept. 8	Decided, green.	Cons.	.37	5.20	2.60	.0016	.0750	.0472	.0278	.48	.0050	.0001	.46	0.4
17599	Oct. 7	Distinct.	Slight, green.	.25	4.10	2.30	.0056	.0492	.0400	.0092	.45	.0050	.0002	.56	0.6
17829	Nov. 10	Distinct, green.	Slight, green.	.35	3.95	2.20	.0116	.0824	.0348	.0476	.49	[illegible]	.0003	.51	0.8
18036	Dec. 8	Distinct.	Slight.	.33	3.75	1.35	.0112	.0354	.0304	.0050	.50	.0080	.0001	.53	0.5

Averages by Years.

-	1890	-	-	.76	4.84	2.21	.0412	.0445	.0327	.0118	.36	.0063	.0001	-	1.0
-	1891	-	-	.65	3.90	1.75	.0328	.0484	.0324	.0160	.34	.0124	.0002	-	0.6
-	1892	-	-	.62	3.95	1.95	.0127	.0475	.0332	.0143	.40	.0193	.0002	-	0.6
-	1893	-	-	.64	3.51	2.14	.0112	.0729	.0329	.0400	.42	.0040	.0002	.60	0.6
-	1894	-	-	.65	3.81	1.89	.0107	[illegible]	.0297	.0198	.44	.0023	.0001	.60	0.5
-	1895	-	-	.42	3.77	1.66	.0053	.0381	.0246	.0135	.50	.0085	.0001	.54	0.7
-	1896	-	-	.36	3.74	1.91	.0068	.0567	.0306	.0261	.45	.0039	.0001	.47	0.4

NOTE to analyses of 1896: Odor, generally distinctly vegetable and frequently sweet and grassy. —— The samples were collected from the pond, near the gate-house, 1 foot beneath the surface. For monthly height of water in this reservoir, see page 219.

LYNN AND SAUGUS.

Microscopical Examination of Water from Glen Lewis Pond, Lynn.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	16	13	11	15	13	10	15	12	9	6	12	10
Number of sample,	15881	16046	16228	16406	16583	16752	16979	17170	17351	17509	17829	18036
PLANTS.												
Diatomaceæ,	186	70	23	712	93	5	32	0	584	1,168	348	4
Asterionella,	183	69	23	680	84	0	0	0	112	16	64	0
Melosira,	0	0	0	14	2	3	0	0	472	1,140	284	3
Synedra,	0	0	0	8	3	0	0	0	0	4	0	0
Tabellaria,	2	1	0	10	4	2	32	0	0	4	0	1
Cyanophyceæ,	1	1	0	9	181	114	3,700	244	280	38	10	5
Anabæna,	1	0	0	0	164	64	2,700	68	24	4	0	0
Clathrocystis,	0	1	0	9	17	46	1,000	168	216	22	3	4
Cœlosphærium,	0	0	0	0	0	4	0	8	36	8	4	0
Microcystis,	0	0	0	0	0	0	0	0	4	4	3	1
Algæ,	0	0	1	19	84	267	4	24	672	32	139	2
Arthrodesmus,	0	0	0	1	76	62	0	0	28	0	0	0
Cœlastrum,	0	0	0	0	0	0	0	0	16	0	0	0
Cosmarium,	0	0	0	0	0	80	0	4	4	0	0	0
Micrasterias,	0	0	0	0	0	7	0	0	0	0	0	0
Protococcus,	0	0	0	16	0	12	4	0	0	20	5	1
Raphidium,	0	0	1	2	0	0	0	0	4	2	54	0
Scenedesmus,	0	0	0	0	0	0	0	0	12	4	0	0
Selenastrum,	0	0	0	0	0	48	0	0	0	4	16	0
Staurastrum,	0	0	0	0	0	64	0	20	608	2	4	0
Staurogenia,	0	0	0	0	8	5	0	0	0	0	32	1
ANIMALS.												
Rhizopoda, Difflugia,	0	0	0	2	0	0	0	0	0	0	0	0
Infusoria,	886	712	27	104	0	2	0	0	32	58	79	604
Dinobryon,	800	564	0	0	0	0	0	0	0	0	15	520
Euglena,	0	1	2	0	0	0	0	0	0	0	4	0
Mallomonas,	5	0	0	0	0	0	0	0	0	0	0	0
Monas,	0	0	0	0	0	0	0	0	0	0	8	0
Peridinium,	76	144	23	104	0	0	0	0	0	2	0	40
Synura,	4	3	2	0	0	0	0	0	0	0	0	0
Trachelomonas,	1	0	0	0	0	2	0	0	32	56	62	44
Vermes, Anurea,	1	0	0	0	0	0	0	0	0	2	0	2
Crustacea,	0	0	0	.02	0	.16	0	.08	0	.04	0	0
Cyclops,	0	0	0	.02	0	.10	0	0	0	.04	0	0
Daphnia,	0	0	0	0	0	.04	0	.08	0	0	0	0
Entomostracan ova,	0	0	0	0	0	.02	0	0	0	0	0	0
Miscellaneous,	0	40	40	80	[illegible]	80	20	40	120	0	40	20
Acarina,	0	0	0	0	0	.28	0	0	.20	0	0	0
Zoöglœa,	0	40	40	80	100	80	20	40	120	0	40	20
TOTAL,	1,072	823	91	926	458	446	3,756	308	1,688	1,296	616	637

LYNN AND SAUGUS.

Chemical Examination of Water from the Saugus River at Howlett's Dam, Saugus.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
15882	Jan. 14	Slight, milky.	Slight.	0.70	6.00	2.75	.0266	.0244	.0206	.0038	1.00	.0600	.0010	0.66	2.7
16046	Feb. 11	Distinct, clayey.	Slight, earthy.	0.70	5.20	1.95	.0032	.0220	.0190	.0030	0.61	.0150	.0003	0.65	2.0
16230	Mar. 10	Slight.	Slight.	0.70	5.45	2.40	.0008	.0196	.0184	.0012	0.58	.0060	.0001	0.67	1.3
16406	Apr. 14	V. slight.	Slight.	0.68	5.20	2.25	.0015	.0226	.0214	.0012	0.52	.0070	.0005	0.66	1.5
16585	May 12	Distinct.	Slight.	1.20	7.25	3.65	.0000	.0440	.0358	.0082	0.83	.0080	.0008	1.07	2.5
16755	June 9	Slight.	Slight.	1.30	8.15	3.55	.0056	.0442	.0410	.0032	0.86	.0030	.0001	1.15	3.2
16961	July 14	Distinct.	Slight, brown.	0.93	4.45	1.85	.0064	.0378	.0282	.0096	0.42	.0000	.0002	–	1.1
17172	Aug. 11	Slight.	Slight.	0.90	9.20	3.00	.0084	.0408	.0376	.0032	1.26	.0000	.0001	0.88	2.5
17362	Sept. 8	Slight.	Slight.	0.70	10.60	3.30	.0016	.0412	.0370	.0042	1.19	.0160	.0004	0.72	3.5
17601	Oct. 7	V. slight.	Slight.	1.40	9.05	3.50	.0074	.0482	.0444	.0038	1.01	.0050	.0010	1.53	3.5
17850	Nov. 10	Slight.	Slight.	1.15	9.10	3.70	.0022	.0388	.0372	.0016	1.18	.0800	.0003	1.13	3.1
18057	Dec. 8	V. slight.	Slight.	0.55	5.40	3.20	.0050	.0282	.0246	.0036	1.02	.0500	.0002	1.14	3.0

Averages by Years.

-	1894	-	-	1.16	6.68	3.36	.0056	.0310	.0272	.0038	1.02	.0112	.0014	0.95	3.5
-	1895	-	-	1.29	8.33	3.62	.0064	.0381	.0349	.0032	0.94	.0125	.0003	1.31	3.1
-	1896	-	-	0.94	7.50	2.92	.0058	.0342	.0304	.0039	0.88	.0168	.0004	[illegible]	2.7

NOTE to analyses of 1896. Odor, distinctly vegetable and mouldy. —— The samples were collected from the river, at Howlett's Dam.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 51.

LYNN AND SAUGUS.

Chemical Examination of Water from the Saugus River at the Line between Saugus and Wakefield, and just above the Point where it is joined by the Branch from Wakefield Centre.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15863	Jan. 14	Slight.	Slight.	1.05	6.55	3.00	.0042	.0310	.0264	.0046	.59	.0080	.0000	1.05	2.6
16047	Feb. 11	Distinct, clayey.	Slight, earthy.	0.60	4.75	2.05	.0004	.0206	.0164	.0042	.42	.0000	—	0.70	1.7
16231	Mar. 10	Slight.	Slight.	0.70	5.10	2.65	.0000	.0234	.0220	.0014	.52	.0050	—	0.68	0.7
16409	Apr. 14	V. slight.	Slight.	0.68	4.50	2.25	.0010	.0226	.0196	.0030	.40	.0000	.0000	0.70	1.6
16556	May 12	Slight.	Slight.	1.70	7.35	3.45	.0026	.0372	.0356	.0016	.74	.0030	.0000	1.83	2.3
16756	June 9	V. slight.	Slight.	1.40	7.60	3.55	.0028	.0450	.0408	.0042	.61	.0050	.0001	1.45	3.2
16962	July 14	Slight.	Slight.	1.00	8.45	2.90	.0023	.0360	.0346	.0014	.42	—	.0003	1.36	4.2
17173	Aug. 11	Distinct.	Cons.	1.33	9.75	3.85	.0068	.0416	.0386	—	.76	.0000	.0002	1.62	4.3
17383	Sept. 8	V. slight.	Slight.	1.80	11.30	4.90	.0012	.0548	.0480	.0068	.59	.0070	.0001	1.42	4.1
17600	Oct. 7	V. slight.	Cons.	1.40	7.85	3.50	—	.0456	.0430	.0026	.78	.0030	.0001	1.53	3.1
17831	Nov. 10	V. slight.	Slight.	1.25	8.15	3.75	.0004	.0432	.0410	.0022	.70	.0056	.0001	2.17	2.9
18069	Dec. 8	V. slight.	Slight.	1.20	8.10	3.70	.0036	.0440	.0202	.0238	.66	.0060	.0001	1.32	3.2

Averages by Years.

-	1894	-	-	1.16	7.71	3.00	.0017	.0287	.0260	.0027	.62	.0038	.0000	1.01	3.2
-	1895	-	-	1.39	7.70	3.37	.0024	.0359	.0336	.0023	.71	.0043	.0001	1.48	3.2
-	1896	-	-	1.19	7.47	3.29	.0022	.0371	.0322	.0049	.60	.0032	.0001	1.27	2.8

NOTE to analyses of 1896: Odor, distinctly vegetable and mouldy.—— The samples were collected from the Saugus River, at a road crossing above Howlett's Pond, just above the point where the river is joined by the branch from Wakefield Centre.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 47.

LYNN AND SAUGUS.

Chemical Examination of Water from a Faucet in Lynn supplied from the Lynn Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
15884	Jan. 14	Slight.	Slight.	1.00	4.75	2.25	.0060	.0226	.0216	.0010	.45	.0070	.0001	.33	1.1
16048	Feb. 11	Distinct, clayey.	Slight, earthy.	0.50	4.00	1.50	.0008	.0146	.0132	.0014	.39	.0130	.0001	.55	1.1
16410	Apr. 14	V. slight.	Slight.	0.37	3.55	1.45	.0030	.0138	.0126	.0012	.41	.0030	.0000	.46	1.0
16587	May 12	Distinct.	Slight.	0.55	4.30	1.90	.0010	.0202	.0182	.0020	.57	.0050	.0000	.56	1.4
16757	June 9	Distinct.	Cons.	0.50	4.05	1.65	.0002	.0248	.0204	.0044	.43	.0060	.0001	.55	1.5
16963	July 14	Distinct.	Cons., rusty.	0.60	4.10	1.50	.0000	.0224	.0192	.0032	.50	.0000	.0001	–	1.3
17174	Aug. 11	Slight.	Slight.	0.95	4.50	1.95	.0018	.0324	.0292	.0032	.48	.0070	.0000	.92	1.0
17384	Sept. 8	V. slight.	Cons.	0.30	5.35	1.80	.0008	.0222	.0136	.0086	.64	.0070	.0001	.33	1.7
17602	Oct. 7	V. slight.	Cons.	0.30	4.40	1.30	.0000	.0208	.0184	.0024	.59	.0030	.0002	.38	1.7
17832	Nov. 10	Slight.	Cons.	0.42	4.65	1.90	.0000	.0204	.0084	.0120	.62	.0070	.0000	.54	1.6
18039	Dec. 8	Slight.	Slight.	0.42	4.90	2.50	.0006	.0250	.0226	.0024	.56	.0090	.0001	.63	1.2

Averages by Years.

–	1894	–	–	0.76	4.60	1.95	.0022	.0216	.0194	.0022	.57	.0065	.0001	.62	1.3
–	1895	–	–	0.76	5.12	2.14	.0017	.0225	.0195	.0030	.65	.0102	.0001	.84	1.7
–	1896	–	–	0.54	4.41	1.79	.0015	.0217	.0179	.0038	.51	.0062	.0001	.58	1.3

Note to analyses of 1896: Odor, vegetable.——The samples were collected from a faucet in the city.

Microscopical Examination of Water from a Faucet in Lynn supplied from the Lynn Water Works.

[Number of organisms per cubic centimeter.]

	1896.										
	Jan.	Feb.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	16	13	15	14	10	16	12	9	8	12	10
Number of sample,	15884	16048	16410	16587	16757	16963	17174	17384	17602	17832	18039
PLANTS.											
Diatomaceæ,	[illegible]	6	47	134	3	78	1	38	46	8	8
Asterionella,	5	4	34	44	2	30	0	13	0	0	0
Cyclotella,	0	0	0	2	0	20	0	0	0	0	0
Melosira,	0	0	0	46	0	0	0	0	0	0	0
Synedra,	8	1	13	28	0	2	0	5	0	2	6
Tabellaria,	0	1	0	14	1	26	1	20	46	6	2
Algæ,	[illegible]	0	0	0	6	8	171	15	6	3	2
Protococcus,	0	0	0	0	6	0	160	6	0	0	2
Raphidium,	1	0	0	0	0	8	0	4	0	0	0
Selenastrum,	0	0	0	0	0	0	8	0	0	3	0
Staurastrum,	0	0	0	0	0	0	3	5	6	0	0
Zoöspores,	7	0	0	0	0	0	0	0	0	0	0

LYNN AND SAUGUS.

Microscopical Examination of Water from a Faucet in Lynn supplied from the Lynn Water Works — Concluded.

[Number of organisms per cubic centimeter.]

	1896.										
	Jan.	Feb.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.
ANIMALS.											
Rhizopoda, Difflugia,	0	0	0	0	0	2	0	0	0	0	[illegible]
Infusoria,	118	2	4	8	0	30	25	7	0	10	152
Dinobryon,	116	0	0	8	0	12	0	0	0	0	136
Euglena,	0	0	0	0	0	12	0	0	0	0	0
Mallomonas,	0	0	0	0	0	0	0	0	0	2	4
Monas,	0	0	0	0	0	0	0	2	0	0	0
Peridinium,	2	2	4	0	0	0	0	0	0	0	4
Raphidomonas,	0	0	0	0	0	0	5	0	0	0	0
Trachelomonas,	0	0	0	0	0	6	20	5	0	8	8
Vermes,	0	0	5	0	0	0	0	3	0	2	0
Anuraea,	0	0	5	0	0	0	0	0	0	0	0
Asplanchna,	0	0	0	0	0	0	0	0	0	2	0
Rotatorian ova,	0	0	0	0	0	0	0	3	0	0	0
Crustacea,	.02	0	0	0	0	0	0	.06	.02	0	0
Bosmina,	0	0	0	0	0	0	0	0	.02	0	0
Cyclops,	.02	0	0	0	0	0	0	.06	0	0	0
Miscellaneous,	0	10	80	61	20	10	60	2	41	60	5
Acarina,	.02	0	0	0	0	0	.04	.04	0	0	0
Sponge spicules,	0	0	0	1	0	0	0	2	1	0	0
Zoöglœa,	0	10	80	60	20	10	60	0	40	60	5
TOTAL,	184	18	136	203	29	128	257	65	93	58	107

Table showing Monthly Depth of Water in Feet in the Ponds and Storage Reservoirs of the Lynn Water Works during the Year 1896.

DATE.	Breed's Pond. High Water, 21.50 Feet.	Birch Pond. High Water, 21.50 Feet.*	Walden Pond. High Water, 17.00 Feet.	Glen Lewis Pond. High Water, 17.00 Feet.*
1896.				
Jan. 1,	20.21	19.33	-	17.63
Feb. 1,	20.00	19.92	-	17.67
March 1,	21.42	21.50	11.00	16.75
April 1,	21.58	22.79	14.83	17.58
May 1,	20.54	22.71	16.67	16.42
June 1,	20.00	22.25	15.00	17.00
July 1,	19.00	21.67	11.76	17.04
Aug. 1,	17.59	19.62	7.08	16.92
Sept. 1,	15.02	18.04	-	16.75
Oct. 1,	16.25	11.83	-	17.08
Nov. 1,	16.75	7.75	-	17.50
Dec. 1,	18.17	8.83	-	17.17

* The water in these ponds is sometimes raised somewhat above ordinary high water.

MALDEN, MEDFORD AND MELROSE.

Water Supply of Malden, Medford and Melrose.

The water of Spot Pond was at high-water level in April, 1896, for the first time since April, 1891. The filling of the pond was due to the decrease in the draft from it caused by the use of water from auxiliary sources of supply introduced by the municipalities using water from the pond.

Chemical Examination of Water from Spot Pond, Stoneham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15859	Jan. 7	Slight.	Slight.	.40	5.50	1.95	.0022	.0212	.0200	.0012	.54	.0100	.0001	.56	1.9
16026	Feb. 4	V. slight.	Slight.	.42	6.05	2.25	.0030	.0216	.0198	.0018	.54	.0100	.0001	.53	2.2
16202	Mar. 3	V. slight.	Slight.	.40	5.50	1.75	.0048	.0184	.0168	.0016	.56	.0050	.0000	.51	2.0
16375	Apr. 6	Slight.	Slight.	[illegible]	4.90	1.60	.0052	.0220	.0200	.0020	.45	.0100	[illegible]	.52	2.0
16557	May 1	Distinct.	Slight.	.35	4.80	1.60	.0034	.0298	.0284	.0014	.60	.0050	.0000	.59	1.8
16559	May 5	Slight.	Cons.	.38	4.45	1.85	.0094	.0216	.0196	.0020	.58	.0020	.0002	.48	1.8
16732	June 2	Distinct.	Slight.	.47	5.40	2.35	.0292	.0346	.0298	.0048	.58	.0030	.0002	.71	2.1
17009	July 6	Slight.	Cons.	.35	6.15	1.70	.0062	.0216	.0184	.0032	.57	.0000	.0000	.67	1.7
17140	Aug. 4	Slight.	Cons.	.35	5.90	2.40	.0010	.0308	.0240	.0068	.58	.0020	.0000	.64	2.1
17354	Sept. 2	Distinct.	Slight.	.32	5.75	2.00	.0016	.0302	.0234	.0068	.58	.0000	.0001	.52	1.9
17619	Oct. 7	Slight.	Cons.	.30	4.65	1.75	.0042	.0242	.0206	.0036	.56	.0030	.0000	.51	1.9
17852	Nov. 3	Slight.	Cons.	.23	5.25	2.35	.0266	.0268	.0218	.0050	.63	.0030	.0002	.44	1.9
18214	Dec. 12	Distinct.	Cons.	.25	4.80	2.00	.0058	.0202	.0176	.0026	.60	.0030	.0003	.44	2.2
Averages by Years															
-	1887*	-	-	.24	4.24	1.32	.0004	.0220	-	-	.47	.0025	-	-	-
-	1888	-	-	.22	3.98	1.24	.0007	.0225	-	-	.44	.0054	.0001	-	-
-	1889	-	-	.26	3.54	1.17	.0017	.0236	.0198	.0038	.44	.0053	.0002	-	-
-	1890	-	-	.22	[illegible]	1.24	.0022	.0223	.0182	.0041	.42	.0078	.0001	-	1.7
-	1891	-	-	.21	3.70	1.27	.0008	.0183	.0161	.0022	.43	.0082	.0001	-	1.4
-	1892	-	-	.17	4.28	1.30	.0035	.0198	.0157	.0041	.50	.0081	.0001	-	1.7
-	1893	-	-	.29	5.70	1.71	.0085	.0197	.0162	.0035	.49	.0105	.0003	.33	2.4
-	[illegible]	-	-	.22	5.90	1.65	.0029	.0210	.0160	.0050	.57	[illegible]	.0001	.38	2.4
-	1895	-	-	.25	5.92	2.02	.0058	.0219	.0196	.0023	.61	.0096	.0000	.44	[illegible]
-	1896†	-	-	.36	5.31	1.98	.0080	.0248	.0214	.0034	.57	.0047	.0001	.51	2.0

* May to December.

† Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1896: Odor, distinctly vegetable and mouldy, occasionally unpleasant.——The samples were collected from the pond. For monthly height of water in the pond, see page 222.

MALDEN, MEDFORD AND MELROSE.

Microscopical Examination of Water from Spot Pond, Stoneham.

[Number of organisms per cubic centimeter.]

	1896.												
	Jan.	Feb.	Mar	Apr	May.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	11	11	10	9	9	11	6	17	7	3	10	18	21
Number of sample,	15859	16026	16292	16373	16557	16559	16733	17009	17140	17354	17619	17852	18214
PLANTS.													
Diatomaceæ,	296	45	58	136	1,124	526	6	272	228	161	696	438	[illegible]
Asterionella,	68	34	44	120	330	332	0	0	0	1	[illegible]	60	96
Cyclotella,	11	5	1	0	500	72	0	0	0	0	0	0	0
Fragilaria,	0	0	0	0	8	0	0	0	0	0	0	0	0
Melosira,	4	0	0	0	0	0	0	0	10	0	0	0	6
Navicula,	2	0	1	0	0	2	0	0	1	0	0	2	2
Stephanodiscus,	0	0	3	8	0	0	2	0	0	0	0	0	0
Synedra,	22	2	0	8	106	32	0	0	3	4	0	0	2
Tabellaria,	196	1	9	0	128	88	4	272	212	156	340	376	12
Cyanophyceæ,	0	0	0	0	2	0	0	0	3	0	20	[illegible]	4
Anabæna,	0	0	0	0	2	0	0	0	3	0	8	0	4
Cœlosphærium,	0	0	0	0	0	0	0	0	0	0	12	0	0
Algæ,	5	1	1	[illegible]	22	0	6	21	5	4	10	2	2
Botryococcus,	0	0	0	0	0	0	0	0	0	0	8	0	0
Protococcus,	0	0	0	0	5	0	6	21	5	0	2	2	0
Raphidium,	5	1	1	4	14	0	0	0	0	4	0	0	2
ANIMALS.													
Rhizopoda, Actinophrys,	0	0	0	2	0	0	0	0	0	0	0	0	0
Infusoria,	5	5	35	68	2	2	0	2	6	28	48	2	0
Codonella,	1	0	0	0	0	0	0	0	0	0	0	1	0
Dinobryon,	0	2	32	60	0	1	0	2	0	0	48	0	0
Euglena,	0	0	0	6	0	0	0	0	0	0	0	0	0
Mallomonas,	1	0	0	4	0	0	0	0	0	0	0	0	0
Monas,	0	0	0	0	2	0	0	0	1	1	0	0	0
Peridinium,	2	3	3	6	0	1	0	0	5	26	0	0	0
Trachelomonas,	1	1	0	2	0	0	0	0	0	1	0	1	0
Crustacea,	0	0	0	0	0	.02	0	0	0	.02	0	0	.02
Bosmina,	0	0	0	0	0	0	0	0	0	.02	0	0	0
Cyclops,	0	0	0	0	0	.02	0	0	0	0	0	0	.02
Miscellaneous, Zoöglœa,	40	10	40	40	30	100	10	20	120	40	40	60	100
TOTAL,	348	62	134	250	1,180	628	22	315	360	233	614	502	224

MALDEN, MEDFORD AND MELROSE.

Table showing Heights of Water in Spot Pond on the First of Each Month in 1896.

[NOTE. — Heights are in feet above or below the crest of the dam. In March the high-water mark was raised 1 foot by placing flash boards on the dam.]

Date.	Height of Water.	Date.	Height of Water.
	Feet.		Feet.
Jan. 1, ...	−1.83	July 1, ...	−1.06
Feb. 1, ...	−1.67	Aug. 1, ...	−2.37
March 1, ...	−0.06	Sept. 1, ...	−3.75
April 1, ...	+0.42	Oct. 1, ...	−4.25
May 1, ...	+0.66	Nov. 1, ...	−5.00
June 1, ...	0.00	Dec. 1, ...	−5.12

Water Supply of Malden.

Chemical Examination of Water from Tubular Wells at Maplewood (Webster Park), Malden.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
15860	Jan 7	None.	None.	.00	31.40	[illegible]	.0052	2.[illegible]	.4500	.0000	.01	15.0	.0010
16027	Feb. 4	None.	None.	.00	32.50	.0000	.0030	2.72	.3500	.0000	.08	16.5	.0060
16201	Mar. 3	None.	None	.00	30.50	.0000	.0012	2.62	.4750	.0000	.00	11.2	.0010
16374	Apr. 6	Distinct.	Slight.	.00	29.90	.0010	.0028	2.81	.4250	.0000	.03	12.4	.0650
16558	May 5	None.	None.	.00	30.70	.0004	.0020	2.98	.4000	.0000	.00	11.9	.0020
16734	June 2	None.	None.	.00	31.00	.0000	.0030	2.76	.4500	.0000	.07	12.1	.0010
17010	July 6	None	None.	.02	30.60	.0000	.0016	3.00	.5000	.0000	.07	16.0	.0150
17141	Aug. 4	None.	None.	.02	33.20	.0002	.0008	3.00	.3500	.0000	.04	14.5	.0050
17365	Sept 2	None.	V. slight.	.00	29.90	.0000	.0016	2.98	.4250	.0001	.08	11.0	.0060
17620	Oct. 7	None.	None.	.01	29.30	.0004	.0020	2.94	.4000	.0000	.03	14.7	.0040
17853	Nov. 8	None.	None.	.00	28.50	.0006	.0016	2.90	.5500	.0000	.01	16.0	.0000
18215	Dec. 12	None.	None.	.00	27.70	.0000	.0000	2.80	.5750	.0000	.01	13.3	.0000

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1887*	-	-	.00	17.08	.0000	.0009	2.20	.4050	-	-	-	-
-	1888	-	-	.00	17.45	.0000	.0003	2.30	.5081	-	-	-	-
-	1889†	-	-	.00	16.95	.0001	.0031	1.75	.5500	.0001	-	7.3	-
-	1890	-	-	.00	18.19	.0002	.0014	2.29	.4952	.0001	-	8.0	-
-	1891	-	-	.00	20.63	.0001	.0007	2.23	.5146	.0001	-	9.6	-
-	1892	-	-	.00	23.00	.0000	.0005	2.36	.5129	.0000	-	11.4	.0335
-	1893	-	-	.00	23.72	.0001	.0011	2.48	.4823	.0000	.02	11.1	.0121
-	1894	-	-	.00	26.28	.0000	.0012	2.74	.3946	.0000	.02	13.2	.0058
-	1895	-	-	.00	32.02	.0001	.0015	2.73	.4317	.0000	.03	14.9	.0092
-	1896	-	-	.00	30.45	.0002	.0021	2.86	.4458	.0000	.04	13.7	.0090

* Three samples in November and December. † June and October.

NOTE to analyses of 1896; Odor, none. — No. 17620 was collected from a drinking fountain; the other samples were collected from a faucet at the pumping station.

Microscopical Examination.

An insignificant number of organisms was found in Nos. 16027, 16374 and 17141; no organisms were found in the other samples.

WATER SUPPLY OF MANCHESTER.

Chemical Examination of Water from the Well of the Manchester Water Works.

[Parts per 100,000.]

Number	Date of Collection	Appearance.			Residue on Evaporation	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity	Sediment.	Color.		Free.	Albuminoid		Nitrates.	[redacted]			
	1896.												
15915	Jan. 22	None.	V. slight.	.00	10.60	.0000	.0004	2.00	.0550	.0000	.02	3.6	.0040
16473	Apr. 23	None.	None.	.00	10.60	.0002	.0006	2.24	.0750	.0000	.01	3.5	.0020
17017	July 20	None.	V. slight.	.00	10.40	.0008	.0006	1.46	.1400	.0000	.01	2.9	.0030
17670	Oct. 20	None.	None.	.00	11.10	.0004	.0002	2.05	.1000	[redacted]	.02	3.8	.0020

Averages by Years.

-	1892	–	–	.00	9.38	.0001	.0003	1.75	.1214	.0001	–	3.4	–
-	1893	–	–	.00	9.64	.0000	[redacted]	1.69	.0975	.0000	.04	3.6	.0096
-	1894	–	–	.00	9.82	.0000	.0006	1.52	.0700	.0000	.01	3.4	.0010
-	1895	–	–	.01	9.87	.0001	.0005	1.80	.0737	.0000	.02	3.3	.0040
-	1896	–	–	.00	10.67	.0003	.0004	1.94	.0950	.0000	.01	3.4	.0027

NOTE to analyses of 1896: Odor, none. — The samples were collected from the well.

Microscopical Examination.

No organisms.

MANSFIELD.

WATER SUPPLY OF MANSFIELD WATER SUPPLY DISTRICT, MANSFIELD.

Chemical Examination of Water from the Well of the Mansfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16974	July 14	None.	None.	.00	2.90	.0000	.0004	.30	.0000	.0001	.06	1.6	.0080

Odor, none. —— The sample was collected from a faucet at the pumping station.

Microscopical Examination.

No organisms.

WATER SUPPLY OF MARBLEHEAD.

Chemical Examination of Water from Faucets in Marblehead supplied from the Marblehead Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16296	Mar. 19	Slight, milky.	Slight.	.10	13.40	.0016	.0036	1.88	.0560	.0000	.06	6.3	.0160
16373	Apr. 7	V. slight.	V slight.	.00	11.60	.0008	.0030	1.79	.0700	.0000	.02	5.[illegible]	.0090
16770	June 10	Slight, milky.	V. slight.	.12	18.20	.0020	.0044	1.46	.0200	.0028	–	9.4	.0250
17155	Aug. 10	Distinct.	V. slight.	.15	19.50	.0038	.0016	1.54	.0060	.0001	.09	7.1	.0540
17551	Oct. 15	None.	None.	.05	16.50	.0028	.0018	1.59	.0230	.0000	.05	7.9	.0330
18054	Dec. 10	Distinct.	Slight.	.10	15.10	.0016	.0020	1.72	.0400	[illegible]	.07	8.9	.0400
Av.	....	....	....	.09	15.72	.0021	.0028	1.67	.0358	.0005	.06	7.5	.0295

Odor of the last sample, distinctly disagreeable; of the others, none.

Microscopical Examination.

An insignificant number of organisms was found in No. 16296; no organisms were found in the other samples.

Water Supply of Marlborough.

During the spring of 1896 about 13,000,000 gallons of water were pumped from Millham Brook, above the storage reservoir, into Lake Williams, from which the supply of the city is drawn. No water was used from the Millham Brook storage reservoir.

Chemical Examination of Water from Lake Williams, Marlborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16659	Feb. 10	Slight, clayey.	Slight.	.12	4.25	1.50	.0020	.0182	.0166	.0016	.48	.0150	.0002	.29	1.7
16575	May 11	Distinct, green.	Slight.	.13	4.25	1.35	.0024	.0260	.0192	.0068	.51	.0030	.0000	.30	1.8
17160	Aug. 10	V. slight.	V. slight.	.10	4.70	1.45	.0000	.0166	.0142	.0024	.55	.0000	.0000	.26	1.7
17300	Nov. 9	V. slight.	Slight.	.05	4.10	1.30	.0000	.0226	.0172	.0054	.55	.0000	.0000	.25	1.6

Averages by Years.

-	1887*	-	-	.06	4.10	0.65	.0010	.0178	-	-	.46	.0017	-	-	-
-	1888	-	-	.05	3.99	0.91	.0006	.0205	-	-	.44	.0054	.0001	-	-
-	1889	-	-	.04	3.92	1.03	.0007	.0220	.0182	.0038	.46	.0064	.0001	-	-
-	1890	-	-	.03	4.41	1.13	.0007	.0206	.0165	.0041	.46	.0078	.0000	-	2.3
-	1891	-	-	.05	4.12	1.20	.0009	.0197	.0162	.0035	.45	.0072	.0001	-	1.8
-	1892†	-	-	.08	4.30	1.48	.0008	.0244	.0174	.0070	.46	.0115	.0003	-	1.7
-	1893	-	-	.05	3.95	0.86	.0014	.0160	.0136	.0033	.40	.0083	.0000	.20	1.7
-	[illegible]	-	-	.09	4.20	1.21	.0001	.0164	.0136	.0019	.45	.0030	.0000	.22	1.7
-	1895	-	-	.11	4.11	1.35	.0005	.0176	.0156	.0020	.46	.0090	.0000	.28	1.9
-	1896	-	-	.10	4.32	1.35	.0011	.0208	.0168	.0040	.52	.0045	.0000	.27	1.7

* June to December. † March and April.

Note to analyses of 1896: Odor, distinctly vegetable. —— The second sample was collected from the lake, and the other samples from a faucet at the pumping station.

Microscopical Examination.

The total number of organisms per cubic centimeter found in each of these samples was as follows No. 16659, 46; No. 16575, 375; No. 17160, 78; No. 17300, 58.

MARLBOROUGH.

Chemical Examination of Water from the North Branch of Millham Brook, near its Entrance to the Millham Brook Storage Reservoir, Marlborough.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15873	Jan. 13	Slight.	V. slight	1.10	4.85	1.60	.0056	.0178	.0154	.0024	.35	.0150	.0001	0.77	1.3
16085	Feb. 10	Slight.	Slight	0.70	4.00	1.45	.0026	.0172	.0160	.0012	.29	.0270	.0001	0.64	1.1
16221	Mar. 9	V. slight	V. slight.	0.70	4.35	1.30	.0014	.0136	.0118	.0018	.23	.0230	.0000	0.61	0.8
16362	Apr. 6	V. slight.	V. slight.	0.73	3.55	1.40	.0008	.0168	.0148	.0020	.26	.0100	.0000	0.62	1.0
16571	May 11	Slight.	Slight.	2.20	5.50	2.50	.0068	[illegible]	.0344	.0062	.32	.0060	.0002	1.79	1.3
16739	June 8	V. slight.	V. slight.	2.20	5.35	2.50	.0040	.0316	.0280	.0036	.22	.0070	.0002	1.89	1.6
16928	July 6	Slight	Slight	1.50	5.35	1.80	.0022	.0302	.0254	.0048	.31	.0070	.0000	0.92	1.3
17150	Aug. 10	V. slight.	Slight.	1.00	5.60	2.15	.0010	.0262	.0230	.0032	.30	.0000	.0002	0.84	1.3
17404	Sept. 8	Distinct.	Slight.	1.00	6.90	2.60	.0006	.0362	.0286	.0076	.32	.0030	.0001	1.13	1.6
17628	Oct. 12	Slight.	Slight.	1.25	7.10	2.75	.0004	.0294	.0266	.0028	.52	.0030	.0001	1.41	1.7
17801	Nov. 9	Slight.	Slight	1.30	7.00	2.90	.0010	.0378	.0314	.0064	.56	.0000	.0001	1.39	1.5
18008	Dec. 7	V. slight.	V. slight.	1.00	5.90	2.15	.0012	.0172	.0154	.0018	.49	.0130	.0001	1.13	1.7
Av.	....	....	....	1.22	5.45	2.11	.0023	.0262	.0226	.0036	.35	.0095	.0001	1.09	1.4

Odor, distinctly vegetable and mouldy, becoming somewhat stronger on heating.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 33.

Chemical Examination of Water from Millham Brook, near its Entrance to the Millham Brook Storage Reservoir, Marlborough.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15874	Jan. 13	Distinct.	V. slight.	0.40	4.95	1.60	.0042	.0132	.0112	.0020	.39	.0350	.0001	0.36	1.6
16036	Feb. 10	Distinct.	Slight.	0.40	4.80	1.65	.0018	.0132	.0118	.0014	.29	.0380	.0001	0.25	1.4
16220	Mar. 9	Slight.	Slight	0.30	3.60	1.35	.0004	.0114	.0084	.0030	.30	.0370	.0000	0.34	1.6
16361	Apr. 6	V. slight.	V. slight.	0.30	3.70	1.00	.0008	.0098	.0094	.0004	.30	.0380	.0000	0.31	1.1
16572	May 11	Slight.	Slight.	1.00	5.10	2.05	.0036	.0234	.0208	.0026	.37	.0100	.0001	0.66	1.9
16740	June 8	V. slight	Slight.	0.90	5.35	2.00	.0048	.0270	.0216	.0054	.26	.0190	.0002	0.74	2.1
16929	July 6	Distinct.	Cons.	0.40	4.80	1.35	.0050	.0148	.0126	.0022	.40	.0160	.0002	0.59	1.7
17157	Aug. 10	V. slight	Slight.	0.55	6.70	2.00	.0026	.0202	.0182	.0020	.38	.0000	.0000	0.69	2.3
17405	Sept. 8	Slight.	Slight.	0.90	8.25	2.60	.0014	.0332	.0314	.0018	.35	.0280	.0003	0.98	2.3
17624	Oct. 12	Slight.	Slight.	0.90	6.75	2.45	.0008	.0254	.0238	.0016	.42	.0050	.0001	1.22	2.2
17802	Nov. 9	V. slight.	V. slight.	0.82	6.00	2.40	.0004	.0294	.0244	.0050	.45	.0050	.0001	1.19	1.9
18007	Dec. 7	V. slight	V. slight.	0.60	6.00	2.10	.0006	.0174	.0148	.0026	.48	.0180	.0001	0.66	2.2
Av.	1896	....	....	0.62	5.47	1.90	.0022	.0199	.0174	.0025	.37	.0209	.0001	0.65	1.9
Av.	1895*	....	....	0.71	4.83	1.94	.0010	.0182	.0169	.0013	.34	.0217	.0001	0.66	1.6

* March to December.

NOTE to analyses of 1896: Odor, vegetable and sometimes mouldy. —— The samples were collected from the brook, near its entrance to Millham Brook reservoir.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 24.

MARLBOROUGH.

Chemical Examination of Water from Millham Brook Storage Reservoir, Marlborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15875	Jan 13	Distinct.	Slight.	0.90	4.50	1.65	.0028	.0338	.0244	.0094	.36	.0070	.0002	0.73	1.4
16037	Feb. 10	Slight.	Slight.	0.60	2.60	1.30	.0050	.0180	.0152	.0028	.25	.0180	.0001	0.55	1.0
16223	Mar. 9	Slight.	Slight.	0.50	3.60	1.20	.0000	.0126	.0114	.0012	.25	.0200	.0006	0.44	0.8
16363	Apr 6	Distinct.	Slight.	0.38	3.35	1.00	.0002	.0290	.0172	.0118	.22	.0060	.0001	0.35	1.3
16573	May 11	Distinct.	Slight.	0.40	3.65	1.50	.0000	.0242	.0168	.0074	.34	.0000	.0000	0.48	1.3
16742	June 8	V. slight.	Slight.	1.00	4.15	1.50	.0076	.0316	.0266	.0050	.28	.0000	.0000	0.68	1.3
16930	July 6	Distinct.	Slight, green.	0.90	4.35	1.55	.0004	.0382	.0280	.0102	.29	.0000	.0000	0.92	1.0
17158	Aug.10	Slight.	Slight.	0.70	4.55	1.75	.0002	.0356	.0256	.0100	.30	.0000	.0001	0.63	1.3
17406	Sept. 8	Distinct.	Cons., brown.	0.98	5.90	2.00	.0084	.0354	.0306	.0048	.33	.0030	.0001	0.62	1.5
17625	Oct. 12	Distinct.	Slight.	1.20	5.00	2.15	.0276	.0380	.0340	.0040	.34	.0100	.0006	0.67	1.6
17803	Nov. 9	Distinct.	Slight.	1.05	5.10	2.20	.0128	.0378	.0364	.0014	.31	.0150	.0010	0.59	1.4
18009	Dec. 7	V. slight.	Slight.	1.10	5.60	2.40	.0042	.0332	.0312	.0020	.36	.0250	.0003	1.17	1.8
Av.	....	....	....	0.80	4.44	1.68	.0056	.0306	.0248	.0058	.30	.0068	.0003	0.69	1.3

Odor, generally distinctly vegetable, frequently mouldy.——The samples were collected from the reservoir, 2 feet beneath the surface.

Microscopical Examination of Water from Millham Brook Storage Reservoir, Marlborough.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	15	12	11	8	12	11	7	11	10	[illegible]	10	8
Number of sample,	15875	16037	16223	16363	16573	16742	16930	17158	17406	17625	17803	18009
PLANTS.												
Diatomaceæ,	33	3	0	[illegible]	547	0	320	0	0	2	108	372
Asterionella,	0	0	0	0	144	0	320	0	0	2	106	352
Fragilaria,	8	0	0	0	0	0	0	0	0	0	0	0
Synedra,	4	3	0	6	400	0	0	0	0	0	2	0
Tabellaria,	21	0	0	18	3	0	0	0	0	0	0	20
Cyanophyceæ,	0	0	0	0	2	0	0	20	4	0	0	0
Anabæna,	0	0	0	0	0	0	0	20	0	0	0	0
Microcystis,	0	0	0	0	[illegible]	0	0	0	4	0	0	0
Algæ,	0	0	1	0	0	4	46	226	1,822	46	128	28
Protococcus,	0	0	1	0	0	1	0	224	264	4	0	0
Raphidium,	0	0	0	0	0	3	0	2	1,558	40	122	28
Staurastrum,	0	0	0	0	[illegible]	0	0	0	0	2	6	0
Zoöspores,	0	0	0	0	0	0	46	0	0	0	0	0

MARLBOROUGH.

***Microscopical Examination of Water from Millham Brook Storage Reservoir, Marlborough* — Concluded.**

[Number of organisms per cubic centimeter.]

	1896. Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	1	0	0	4	[illegible]	0	0	0	0
Infusoria,	1	2	1	1,337	8	0	52	10	6	45	30	8
Cryptomonas,	0	0	0	1,300	0	0	0	0	0	0	0	0
Dinobryon,	0	0	1	35	5	0	0	0	0	0	0	0
Euglena,	0	0	0	0	1	0	0	0	0	1	0	0
Mallomonas,	0	0	0	1	0	0	40	0	0	0	0	4
Monas,	0	0	0	0	0	0	2	0	0	0	0	0
Peridinium,	0	2	0	1	0	0	0	0	0	0	0	0
Raphidomonas,	0	0	0	0	0	0	0	7	0	0	0	0
Synura,	1	0	0	0	1	0	0	0	0	0	0	0
Trachelomonas,	0	0	0	0	1	0	0	1	6	44	30	4
Vorticella,	0	0	0	0	0	0	10	2	0	0	0	0
Vermes,	0	1	0	3	3	0	0	1	0	1	0	0
Anuraea,	0	0	0	0	2	0	0	1	0	1	0	0
Asplanchna,	0	0	0	3	0	0	0	0	0	0	0	0
Rotatorian ova,	0	1	0	0	1	0	0	0	0	0	0	0
Crustacea,	0	0	0	0	.04	.02	[illegible]	0	0	0	0	0
Cyclops,	0	0	0	0	.04	0	.04	0	0	0	0	0
Daphnia,	0	0	0	0	0	.02	0	0	0	0	0	0
Miscellaneous,	5	5	20	160	40	0	[illegible]	40	20	5	30	10
Acarina,	0	0	0	0	0	.02	.06	0	0	0	0	0
Zoöglea,	5	5	20	160	40	0	5	40	20	5	30	10
TOTAL,	30	11	22	1,525	800	4	427	307	1,352	99	296	416

Chemical Examination of Water from Millham Brook Storage Reservoir, Marlborough, collected near the Bottom.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16038	Feb. 10	Slight.	Slight.	0.70	5.00	1.95	.0056	.0242	.0200	.0042	.26	.0130	.0002	0.66	1.6
16232	Mar. 9	Distinct, clayey.	Slight.	0.70	4.20	1.40	.0036	.0222	.0192	.0030	.24	.0150	.0000	0.52	1.1
16364	Apr. 6	Slight.	Slight.	0.38	3.45	1.25	.0000	.0196	.0128	.0068	.24	.0070	.0000	0.39	1.3
16674	May 11	Distinct, green.	Slight.	0.47	4.10	1.80	.0046	.0274	.0194	.0080	.34	.0020	.0000	0.45	1.4
16741	June 8	V. slight.	V. slight.	1.00	4.70	1.60	.0078	.0330	.0300	.0030	.28	.0030	.0000	0.65	1.4
16931	July 6	Distinct.	Cons.	1.25	5.05	1.90	.0348	.0360	.0316	.0044	.28	.0380	.0000	–	1.4
17159	Aug. 10	Distinct.	Cons.	2.60	7.30	2.70	.0948	.0542	.0306	.0236	.30	.0000	.0000	1.28	2.3
17407	Sept. 8	Decided.	Cons., brown.	1.05	6.35	2.30	.0142	.0352	.0306	.0046	.34	.0030	.0001	0.76	1.6
17625	Oct. 12	Distinct.	Slight.	1.15	5.10	2.10	.0294	.0392	.0360	.0032	.35	.0070	.0006	0.87	1.6
17804	Nov. 9	Distinct.	Slight.	1.05	4.90	1.90	.0120	.0382	.0362	.0020	.34	.0160	.0008	0.67	1.3
18010	Dec. 7	V. slight.	Slight.	1.05	5.60	2.40	.0042	.0348	.0320	.0028	.42	.0160	.0002	1.09	1.8
Av.	....	....	....	1.04	5.07	1.94	.0185	.0331	.0271	.0060	.31	.0110	.0002	0.92	1.5

Odor, generally vegetable, sometimes mouldy, and occasionally unpleasant or disagreeable. —— The *samples were collected* from the reservoir, 2 feet above the bottom.

MARLBOROUGH.

Microscopical Examination of Water from Millham Brook Storage Reservoir, Marlborough, collected near the Bottom.

[Number of organisms per cubic centimeter.]

	1896.										
	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	12	11	8	15	11	7	11	10	15	10	8
Number of sample,	16088	16223	16364	16574	16741	16931	1[illegible]	17407	17626	17804	18010
PLANTS.											
Diatomaceæ,	7	0	13	176	4	72	2	3	0	38	[illegible]
Asterionella,	0	0	0	116	0	72	2	0	0	38	416
Synedra,	7	0	5	60	0	0	0	0	0	0	0
Tabellaria,	0	0	8	0	4	0	0	3	0	0	0
Algæ,	0	0	0	4	48	14	3	376	54	138	24
Protococcus,	0	0	0	4	0	3	1	0	10	[illegible]	0
Raphidium,	0	0	0	0	48	11	2	376	44	136	24
Fungi, Crenothrix,	16	5	0	0	0	0	0	0	0	0	0
ANIMALS.											
Infusoria,	0	3	1,022	48	0	1	[illegible]	1	24	14	[illegible]
Cryptomonas,	0	0	1,000	[illegible]	0	0	0	0	0	0	0
Dinobryon,	0	0	11	[illegible]	0	0	0	0	0	0	0
Mallomonas,	0	0	0	0	0	0	0	0	0	0	4
Monas,	0	3	5	5	0	1	1	0	0	0	0
Peridinium,	0	0	0	36	0	0	0	0	0	0	0
Trachelomonas,	0	0	6	2	0	0	2	1	24	14	4
Vermes, Rotifer,	0	0	0	0	0	0	0	3	0	0	0
Crustacea,	0	0	0	.12	0	0	0	.12	.02	0	0
Bosmina,	0	0	0	0	0	0	0	.10	0	0	0
Cyclops,	0	0	0	.12	0	0	0	0	.02	0	0
Daphnia,	0	0	0	0	0	0	0	.02	0	0	0
Miscellaneous,	20	60	80	200	5	20	0	0	20	40	10
Acarina,	0	.26	0	.04	0	0	0	.12	0	0	0
Zoöglœa,	20	60	80	200	5	20	0	0	20	40	10
TOTAL,	[illegible]	68	1,115	426	57	107	5	388	98	228	456

MARSHFIELD.

WATER SUPPLY OF BRANT ROCK, MARSHFIELD. — BRANT ROCK WATER COMPANY.

Chemical Examination of Water from the Works of the Brant Rock Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
17146	Aug. 6	None.	None.	.01	13.70	.0000	.0010	2.97	.0660	.0000	.03	1.7	.0000

Odor, none. —— The sample was collected from a faucet at the pumping station.

Microscopical Examination.

No organisms.

WATER SUPPLY OF MAYNARD.

Chemical Examination of Water from White Pond, Maynard.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16682	May 27	Slight, clayey.	V. slight.	.12	2.35	0.60	.0004	.0078	.0068	.0010	.23	.0050	.0000	.17	1.3
17712	Oct. 26	V. slight.	Slight.	.06	2.10	0.80	.0004	.0198	.0154	.0044	.22	.0000	.0000	.11	0.3

Odor of the first sample, none; of the second, faintly vegetable, becoming distinctly vegetable and mouldy on heating. —— The first sample was collected from a faucet in the town, and the last from the pond. The sample collected in the village represents pond water mixed with a large amount of ground water which finds its way into the pipe leading from the pond to the pumping station.

Microscopical Examination.

No. 16682. Diatomaceæ, *Asterionella*, 6; *Cyclotella*, 3; *Tabellaria*, 516. Infusoria, *Dinobryon*, 1. Total, 526.

No. 17712. Diatomaceæ, *Asterionella*, 4; *Fragilaria*, 2; *Pinnularia*, 2; *Synedra*, 22; *Tabellaria*, 6. Algæ, *Raphidium*, 8; *Scenedesmus*, 1; *Staurastrum*, 1; *Staurogenia*, 1. Infusoria, *Dinobryon*, 12; *Peridinium*, 4. Miscellaneous, *Zoöglœa*, 10. Total, 73.

MEDFIELD.

Chemical Examination of Water from a Spring in Medfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
17296	[redacted] Aug. 26	None.	V. slight.	.01	3.80	.0000	.0024	.29	.0000	.0000	.04	1.3	.0010

Odor, none. —— The sample was collected from a spring near Vine Brook, about one-third of a mile above North Street. This spring is used as a source of water supply by a large straw factory and by a portion of the village of Medfield.

Microscopical Examination.

No organisms.

WATER SUPPLY OF MEDFIELD INSANE ASYLUM.

The advice of the State Board of Health to the trustees of the Medfield Insane Asylum with reference to an additional water supply for the asylum may be found on page 24 of this volume. Analyses of samples of water collected from Farm Pond in Sherborn during the investigations made by the Board may be found under "Sherborn" in this report.

WATER SUPPLY OF MEDFORD.

Water from Wright's Pond was used for the supply of the city from the beginning of the year until May 28, 1896, at which time its use was discontinued, owing to the unsatisfactory quality of the water.

For information regarding the water supply of Medford from Spot Pond and for analyses of samples of water from the pond, see pages 220 to 222.

MEDFORD.

Chemical Examination of Water from Wright's Pond, Medford.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
15967	Jan. 23	Distinct.	Cons.	.47	5.60	2.40	.0034	.0274	.0196	.0078	.46	.0050	.0000	.61	2.3
16163	Feb 25	Distinct.	Slight, green.	.60	5.75	1.55	.0000	.0220	.0174	.0046	.44	.0000	.0001	.51	2.1
16355	Apr. 3	Distinct.	Cons., yellow.	.30	4.55	1.35	.0000	.0228	[illegible]	.0062	.45	.0030	.0000	.47	2.3
16519	May 1	Decided, green.	Cons., brown.	.40	4.50	1.35	.0020	.0240	.0160	.0080	.32	.0020	.0000	.47	2.1
16690	May 26	Distinct.	Cons., brown.	.42	5.20	1.90	.0038	.0252	.0208	.0044	.41	.0000	.0000	.47	2.3
Av.*	....	....	....	.42	5.20	1.50	.0022	.0242	.0175	.0067	.43	.0022	.0000	.51	2.2

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, distinctly vegetable, becoming somewhat stronger on heating. —— The samples were collected from the pond.

Microscopical Examination of Water from Wright's Pond, Medford.

[Number of organisms per cubic centimeter.]

	1896.				
	Jan.	Feb.	April.	May.	June.
Day of examination,	30	29	4	5	3
Number of sample,	15967	16163	16355	16519	16690
PLANTS.					
Diatomaceæ,	2,421	1,694	[illegible]	6,014	17
Asterionella,	65	128	0	0	0
Cyclotella,	92	1	0	0	0
Synedra,	2,256	1,590	2,000	6,000	9
Tabellaria,	18	15	9	14	8
Algæ,	10	2	10	0	3
Arthrodesmus,	3	2	0	0	3
Protococcus,	0	0	10	0	0
Raphidium,	7	0	0	0	0
Fungi, Crenothrix,	22	0	[illegible]	0	0

MEDFORD.

Microscopical Examination of Water from Wright's Pond, Medford — Concluded.

[Number of organisms per cubic centimeter.]

	1896.				
	Jan.	Feb.	April.	May	June.
ANIMALS.					
Infusoria,	0	36	54	0	7
Bursaria,	0	0	2	0	0
Monas,	0	0	4	0	0
Peridinium,	0	36	48	0	0
Trachelomonas,	0	0	0	0	7
Vermes, Anurea,	0	0	0	0	1
Crustacea,	.02	0	0	0	.12
Bosmina,	0	0	0	0	.02
Cyclops,	.02	0	0	0	.04
Entomostracan ova,	0	0	0	0	.06
Miscellaneous, Zoöglœa,	60	10	0	0	40
TOTAL,	2,523	1,712	2,072	8,014	68

Chemical Examination of Water from Underdrains beneath the Sewers, Medford.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16246	Mar. 11	V. slight.	V. slight.	.01	13.50	.0472	.0048	2.91	.7200	.0012	.09	5.6	.0180
17012	July 16	Distinct, white.	Slight.	.03	133.00	.0680	.0040	53.50	.2000	.0009	.18	23.6	.0120
17860	Nov. 11	Slight.	Cons.	.03	43.70	.0496	.0050	14.66	.6000	.0020	.11	10.9	.0270
Av.	....	....	....	.02	63.07	.0549	.0016	23.70	.5067	.0014	.13	13.3	.0190

NOTE to analyses of 1896: Odor, none. —— The samples were collected from the underdrain in Boston Avenue, near the Mystic River.

Microscopical Examination.

No. 16246. Miscellaneous, *Zoöglœa*, 150.
No. 17860. Fungi, *Crenothrix*, 350. Miscellaneous, *Zoöglœa*, 100. Total, 450.
No organisms were found in the remaining sample.

MEDWAY.

The advice of the State Board of Health to the town of Medway with reference to the introduction of a water supply from sources near the village of West Medway may be found on page 25 of this volume.

The advice of the Board to the Medway Water Company with reference to securing a supply of water from wells located in the valley of the Charles River in the easterly part of Medway may be found on pages 25 to 27 of this volume.

Analyses of samples of water collected from various sources in the town during the investigations are given in the following tables. An analysis of a sample of water from the Charles River at Medway may be found in the chapter on "Examination of Rivers," in a subsequent portion of this report.

Chemical Examination of Water from a Tubular Test Well and from a Spring in Medway.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16832	June 15	None.	Slight.	.01	6.90	.0000	.0014	.40	.0960	.0000	.08	2.1	.0050
16833	June 15	Slight.	Slight.	.03	2.90	.0004	.0020	.23	.0010	.0000	.02	0.7	.0060

Odor, none.——The first sample was collected from a tubular test well on the easterly side of Chicken Brook and about 100 feet north of Mechanic Street in West Medway, near the site of an old dam; the last sample was collected from a spring about 500 feet west of Chicken Brook, a short distance above the site of the old dam.

Microscopical Examination.

An insignificant number of organisms was found in sample No. 16833; no organisms were found in the other sample.

MEDWAY.

Chemical Examination of Water from Test Wells, Medway.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	[illegible] as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16807	May 15	None.	Cons., sandy.	.01	13.70	.0000	.0000	1.50	.3750	.0000	.00	4.9	.0100
16716	June 2	V. slight.	Slight, sandy.	.00	12.00	.0000	.0020	1.30	.2400	.0000	.04	4.2	.0120
16808	May 15	None.	None.	.00	6.50	.0000	[illegible]	0.91	.2000	.0000	.01	3.0	.0020
16717	June 2	None.	Slight, sandy.	.00	8.00	.0006	.0006	0.85	.2000	.0000	.00	3.4	.0070
16809	May 15	None.	None.	.00	9.00	.0000	.0002	0.73	.1250	.0000	.01	3.9	.0020
16718	June 2	None.	None.	.00	8.60	.0004	.0016	0.60	.0800	.0000	.06	4.3	.0070
17367	Sept. 4	None.	None.	.02	10.00	.0000	.0008	0.93	.2000	.0000	.05	4.2	.0010

Odor, none. —— The samples were collected from tubular test wells on the south bank of the Charles River, in the easterly part of the town of Medway, as follows: the first two samples, from a test well about 600 feet below the Ray & Wilson dam; the next two samples, from a well about 120 feet further down the stream; and the last three samples, from a well about 700 feet below the Ray & Wilson dam. Each of the wells was about 60 feet from the river. The last sample was collected after pumping continuously from the well for one hundred and four hours, at a rate of 70 gallons per minute.

Microscopical Examination.

No organisms.

Water Supply of Melrose.

For information regarding the water supply of Melrose from Spot Pond and for analyses of water from the pond, see pages 220 to 222. The auxiliary supply from tubular wells in the valley of Spot Pond Brook, which was used during the years 1894 and 1895, was abandoned in May, 1896, since which time the entire supply for the town has been drawn from Spot Pond.

Chemical Examination of Water from Tubular Wells in the Valley of Spot Pond Brook, near Wyoming Avenue, used as an Additional Source of Water Supply for Melrose.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16016	Feb. 4	None.	Slight, earthy.	.02	14.50	.0000	.0038	1.34	.0020	.0002	.09	6.7	.0050

Odor, none. —— The sample was collected from a faucet in Melrose, supplied from the tubular wells.

Microscopical Examination.

No organisms.

MERRIMAC.

MERRIMAC.

The advice of the State Board of Health to the town of Merrimac relative to a proposed public water supply for that town may be found on pages 27 to 29 of this volume.

Chemical Examination of Water from Test Wells in Merrimac.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
17213	Aug. 15	Distinct, milky.	V. slight.	.35	13.10	.0012	.0014	.36	.0000	.0000	.02	7.0	0.0060
17265	Aug. 21	Slight.	Cons., sandy.	.03	4.30	.0000	.0000	.31	.0000	.0000	.04	2.8	0.0040
17299	Aug. 24	V. slight.	V. slight.	.06	4.70	.0000	.0002	.21	.0280	.0000	.05	1.3	0.0280
17300	Aug. 26	Distinct.	Cons., rusty.	.40	23.90	.0036	.0026	.25	.0050	[illegible]	[illegible]	9.7	1.0400
17966	Nov. 27	V. slight.	V. slight.	.26	5.20	.0006	.0034	.43	.0030	.0000	.37	1.6	0.0030

Odor of the first sample, none, becoming distinctly mouldy on heating; of the others, none. —— The first sample was collected from a tubular test well in the valley of Cobbler's Brook, about 400 feet down stream from the Tukesbury Dam; the second, from a tubular test well near the south-westerly shore of Lake Attitash or Kimball's Pond; the third, from a tubular test well in the Plains, so-called, south of Lake Attitash and near the divide between Lake Attitash and the Merrimack River; the fourth, from a tubular well in the valley of Back River, a tributary of Cobbler's Brook, located about 700 feet below Sargent's Millpond; the last, from a spring on the northerly side of Back River.

Microscopical Examination.

No organisms.

Chemical Examination of Water from Back River, Merrimac.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
17751	Oct. 30	Slight.	Cons., dark.	1.10	7.00	2.75	.0004	.0274	.0214	.0060	.47	.0020	.0000	1.03	3.2
17752	Oct. 30	None.	V. slight.	1.30	6.50	3.40	.0000	.0384	.0328	.0056	.50	.0000	[illegible]	1.43	1.6
17914	Nov. 18	V. slight.	Slight.	1.10	6.15	2.65	.0010	.0298	.0272	.0026	.50	.0020	.0000	1.23	1.6

Odor, distinctly vegetable. —— The first sample was collected from Back River, about 600 feet above Cobbler's Brook; the last two samples, from the millpond at Sargent's Mill.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 50.

MERRIMAC.

Chemical Examination of Water from Cobbler's Brook in Merrimac.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
17723	Oct. 26	V. slight.	Slight.	.90	6.40	2.95	.0006	.0262	.0226	.0036	.50	.0030	.0001	1.07	1.6
17724	Oct. 26	Slight	Cons.	.80	6.95	2.75	.0010	.0228	.0214	.0014	.47	.0000	.0000	0.95	2.0
17912	Nov. 18	V. slight.	Slight.	.85	6.85	2.50	.0006	.0222	.0202	.0020	.42	.0000	.0000	0.93	1.9
17913	Nov. 18	Slight.	Cons.	.80	6.30	2.45	.0008	.0212	.0168	.0044	.44	.0000	.0001	0.79	1.9

Odor, faintly vegetable, becoming somewhat stronger on heating. —— Nos. 17723 and 17912 were collected from the west branch of Cobbler's Brook, at the first road crossing above the old Tukesbury dam; the remaining samples were collected from the brook, at the Tukesbury dam.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 20.

Water Supply of Methuen.

Chemical Examination of Water from the Tubular Wells of the Methuen Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15876	Jan. 13	None.	None.	.02	7.50	.0000	.0014	.25	.0070	.0000	.07	3.1	.0090
16215	Mar. 9	None.	None.	.05	7.60	.0028	.0006	.24	.0070	.0001	.08	3.3	.0100
16578	May 11	V. slight.	Slight.	.10	6.50	.0000	.0018	.26	.0080	.0000	.03	2.7	.0270
16957	July 9	None.	None.	.08	7.20	.0000	.0016	.25	.0120	.0000	-	3.0	.0030
17410	Sept. 8	None.	None.	.05	9.20	.0000	.0012	.26	.0050	.0000	.02	3.3	.0120
17836	Nov. 10	None.	V. slight.	.05	8.50	.0000	.0024	.24	.0030	.0005	.10	3.7	.0180

Averages by Years.

-	1894*	-	-	.02	7.77	.0002	.0033	.25	.0057	.0000	.05	3.1	.0050
-	1895	-	-	.06	7.44	.0001	.0030	.26	.0062	.0000	.09	3.2	.0128
-	1896	-	-	.06	7.58	.0005	.0015	.25	[illegible]	.0001	.06	3.2	.0128

* September, October and December.

Note to analyses of 1896: Odor, none. —— Nos. 15876, 16578 and 16957 were collected from a faucet at the pumping station; the remaining samples, from a faucet in a building near the pumping station.

Microscopical Examination.

An insignificant number of organisms was found in sample No. 16578; no organisms were found in the remaining samples.

METHUEN.

Chemical Examination of Water from the Covered Reservoir of the Methuen Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15677	Jan. 13	None.	None.	.02	7.20	.0002	[redacted]	.24	[redacted]	.0000	.05	2.9	.0070
16216	Mar. 9	Slight, milky.	Slight.	.12	7.60	.0000	.0028	.24	.0080	[redacted]	.09	3.0	.0240
16579	May 11	V. slight	V. slight.	.05	[redacted]	.0004	.0016	.26	.0070	.0001	.03	3.0	.0080
16956	July 8	None.	None.	.08	7.80	.0000	.0022	.26	.0000	.0000	–	4.1	.0040
17409	Sept. 8	None.	None.	.03	8.00	.0000	.0008	.26	.0070	.0000	.04	3.1	.0010
17835	Nov. 10	None.	None.	.04	6.40	.0006	.0034	[redacted]	.0050	.0000	.10	3.5	.0060

Averages by Years.

-	1894*	-	-	.02	7.33	.0006	.0018	.25	.0063	.0003	.08	3.1	[redacted]
-	1895	-	-	.07	7.87	.0001	.0028	.26	[redacted]	[redacted]	.06	3.3	.0147
-	1896	-	-	.06	7.62	.0002	.0022	.25	.0067	[redacted]	.06	3.3	.0083

* September, October and December.

NOTE to analyses of 1896: Odor, none. —— The samples were collected from a faucet near the reservoir.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

MIDDLEBOROUGH.

WATER SUPPLY OF MIDDLEBOROUGH FIRE DISTRICT, MIDDLEBOROUGH.

Chemical Examination of Water from the Well of the Middleborough Fire District.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15855	Jan. 9	V. slight.	V. slight.	.50	6.70	.0008	.0018	.74	.0830	.0000	.06	2.6	[illegible]
16195	Mar. 4	None.	None.	.00	7.40	.0004	.0036	.74	.1060	[illegible]	.07	2.6	.0180
16550	May 6	None.	None.	.10	5.90	.0000	.0046	.72	.0580	.0000	[illegible]	2.3	.0220
16950	July 8	Slight.	Slight.	.13	5.56	.0000	.0050	[illegible]	.0120	.0002	–	2.3	.0280
17385	Sept. 8	Slight, milky.	None.	.22	6.90	.0002	.0042	.67	.0180	.0000	.14	2.1	.0480
17785	Nov. 4	Distinct, milky.	Slight.	.12	6.80	.0002	.0038	.78	.0600	.0000	.10	2.7	.0440

Averages by Years.

–	1887*	–	–	.00	8.39	[illegible]	.0019	.96	.1519	–	–	–	–
–	1888	–	–	.00	8.67	.0001	.0025	.96	.1494	.0001	–	–	–
–	1889†	–	–	.00	8.77	.0002	.0024	.98	.1770	.0001	–	–	–
–	1893‡	–	–	.05	6.53	.0006	.0024	.73	.0775	.0001	.08	2.6	.0070
	1894*	–	–	.09	5.16	.0004	.0032	.69	.0572	.0001	.06	2.3	.0237
–	1895	–	–	.06	6.74	.0001	.0028	.74	.0687	.0000	.06	2.6	.0167
–	1896	–	–	.18	6.54	.0003	.0038	.72	.0565	.0000	.09	2.4	.0268

* June to December. † January to May. ‡ April and September.

NOTE to analyses of 1896. Odor, none, except in January, July and November, when it was faintly earthy on heating.—The samples were collected from a faucet at the pumping station, while pumping.

Microscopical Examination.

An insignificant number of organisms was found in Nos. 15855 and 17385; no organisms were found in the remaining samples.

WATER SUPPLY OF MIDDLETON.

(*See Danvers.*)

MILLBURY.

WATER SUPPLY OF MILLBURY. — MILLBURY WATER COMPANY.

Chemical Examination of Water from the Well of the Millbury Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16001	Feb. 3	None.	None.	.03	4.70	.0008	.0158	.35	.0200	.0000	.17	1.4	.0160
16330	Mar. 24	None.	Slight.	.06	4.30	.0000	.0028	[illegible]	.0130	.0001	.04	3.1	.0010
16766	June 10	V. slight.	V. slight.	.00	4.00	.0002	.0014	.20	.0230	.0000	.06	1.6	.0060
17079	July 27	Distinct, milky.	Slight, rusty.	.18	4.40	.0000	.0012	.20	.0070	.0003	.03	1.4	.0750
17961	Nov. 24	None.	None.	.00	5.70	.0006	.0006	.22	.0120	.0000	.02	2.8	.0010
Av.	....	....	....	.04	4.62	.0003	.0044	.25	[illegible]	.0001	.06	2.1	.0194

Odor of the first three samples, none; of the fourth, faintly earthy; of the last, none, becoming distinctly earthy on heating. — The samples were collected from a faucet at the pumping station.

Microscopical Examination.

No organisms.

WATER SUPPLY OF MILLIS.

Chemical Examination of Water from the Aqua Rex Spring, Millis.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16942	July 8	None.	None.	.00	6.00	.0000	.0008	.48	.0350	.0000	–	2.3	.0050

Odor, none. — The sample was collected from the spring.

Microscopical Examination.

No organisms.

WATER SUPPLY OF MILTON. — MILTON WATER COMPANY.

The water supplied by this company to the town is purchased from the Hyde Park Water Company. Analyses of samples of the water may be found on pages 180 to 182.

WATER SUPPLY OF MONSON.

Chemical Examination of Water from a Faucet in Monson, supplied from the Monson Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
15975	Jan. 28	None.	None.	.00	4.30	.0010	.0016	.11	.0120	.0000	.06	1.7	.0060
16319	Mar. 25	None.	Slight.	.00	4.10	.0004	.0014	.16	.0120	.0000	.02	2.7	.0080
16661	May 26	V. slight.	V. slight.	[illegible]	2.70	.0002	.0009	.18	.0120	.0000	.01	1.9	.0080
17083	July 28	None.	None.	.01	4.70	.0000	.0008	.12	.0070	.0000	.00	1.8	.0080
17552	Sept. 22	V. slight.	Slight, floc.	.01	3.70	.0006	.0080	.13	.0090	[illegible]	[illegible]	1.4	.0270
17947	Nov. 23	None.	Slight, rusty.	.01	4.20	.0000	[illegible]	.14	.0100	[illegible]	.04	1.8	.0100
Av.	....	....	....	.00	3.95	.0004	.0015	.18	.0103	[illegible]	.03	1.7	.0092

Odor of the first four samples, none; of the fifth, faintly earthy, disappearing on heating; of the last, distinctly mouldy. —— The samples were collected from faucets in the town.

Microscopical Examination.

An insignificant number of organisms was found in No. 17947; no organisms were found in the remaining samples.

MASSACHUSETTS HOSPITAL FOR EPILEPTICS, MONSON. — *Chemical Examination of Water from Test Wells in the Valley of the Quaboag River, Palmer.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
17858	Nov. 11	None.	V. slight.	.00	5.50	.0002	.0022	.33	.1500	.0000	.00	1.7	0.0190
17859	Nov. 11	None.	V. slight.	.48	6.20	.0026	.0030	.08	.0070	.0000	.24	1.3	0.9000
18004	Dec. 5	Slight.	Cons.	.35	6.50	.0022	.0056	.12	.0080	.0001	.28	2.1	[illegible]
18005	Dec. 5	Slight.	Cons.	.15	5.80	.0016	.0030	.10	.0070	.0000	.25	1.4	1.0100
17910	Nov. 18	None.	Slight.	.00	2.80	.0000	.0004	.10	.0350	.0000	.00	0.8	[illegible]
17911	Nov. 18	Decided.	Cons., clayey	.02	2.60	.0000	.0004	.13	.0180	.0001	.01	1.1	0.0080

Odor, none. —— The samples were collected from tubular test wells located on the south-westerly side of the Quaboag River, just above the first railroad bridge above Palmer.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows. No. 18004, 300; No. 18005, 240; no organisms were found in the other samples.

MONSON.

Chemical Examination of Water from the West Reservoir and a Brook at the State Hospital for Epileptics, Monson.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
17966	Nov. 27	None.	Slight.	.10	4.05	[illegible]	.0006	.0096	.0076	.0020	.29	.0150	.0000	.19	–
18170	Dec. 21	Distinct, green.	Slight, green.	.06	3.50	[illegible]	.0006	.0092	.0052	.0040	.27	.0200	.0000	.14	1.3
18169	Dec. 21	V. slight.	Slight.	.10	3.25	0.70	.0006	.0052	.0042	.0010	.19	.0100	.0000	.10	1.8

Odor, distinctly vegetable, and of the last sample, also mouldy. —— The first two samples were collected from the West Reservoir; the last, from an ice pond on a brook near the buildings, which has been used as a source of additional supply for the school. The State Primary School is no longer in existence, and the grounds are to be occupied by a State Hospital for Epileptics.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows: No. 17966, 111; No. 18170, 2,368; No. 18169, 6.

Water Supply of Turner's Falls Fire District, Montague.

Chemical Examination of Water from Lake Pleasant, Montague.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
15907	Jan. 20	V. slight	V. slight.	.06	2.35	0.70	.0048	.0080	.0072	.0008	.15	.0000	.0000	.11	0.5
16294	Mar. 18	V. slight.	V. slight.	.08	2.10	0.85	.0000	.0094	.0078	.0016	.15	.0080	.0000	.16	0.2
16650	May 19	V. slight.	V. slight.	.01	2.30	0.85	.0000	.0060	.0056	.0004	.14	.0030	.0000	.06	0.6
17030	July 21	V. slight.	V. slight	.02	2.45	0.55	.0004	.0106	.0072	.0034	.14	.0060	.0000	.09	0.2
17363	Sept. 2	Slight.	Cons.	.03	2.10	0.70	.0004	.0108	.0068	.0040	.13	.0000	.0000	.12	0.5
17820	Nov. 9	Slight.	Slight.	.03	2.00	0.70	.0014	.0134	.0082	.0052	.14	.0000	.0000	.11	0.6

Averages by Years

–	1887*	–	–	.03	2.74	0.81	.0018	.0110	–	–	.10	.0007	–	–	–
–	1888	–	–	.00	2.33	0.49	.0027	.0071	–	–	.09	.0085	.0000	–	–
–	1889†	–	–	.01	2.19	0.40	.0008	.0064	.0052	.0012	.09	.0065	.0000	–	–
–	1893	–	–	.04	2.28	0.68	.0023	.0115	.0083	.0032	.12	.0045	.0000	.11	0.6
–	1894	–	–	.04	2.13	0.65	.0022	.0097	.0076	.0021	.12	.0025	.0000	.11	0.4
–	1895	–	–	.05	2.32	0.72	.0023	.0096	.0073	.0022	.13	.0056	.0000	.11	0.6
–	1896	–	–	.04	2.22	0.72	.0012	.0097	.0071	.0026	.14	.0023	.0000	.11	0.4

* June to December. † January to June.

Note to analyses of 1896 Odor of No. 16650, sweet; of No. 17820, decidedly unpleasant; of the others, none. —— No. 17363 was collected from the lake; the remaining samples, from a faucet in the pumping station.

Microscopical Examination.

The total number of organisms per cubic centimeter found in each of these samples was as follows: No. 15907, 0; No. 16294, 31; No. 16650, 86; No. 17030, 125; No. 17363, 704; No. 17820, 241.

MONTAGUE.

The advice of the State Board of Health to the water supply committee of the village of Miller's Falls, relative to the introduction of a public water supply for the village of Miller's Falls, in the towns of Montague and Erving, may be found on pages 30 and 31 of this volume. Analyses of samples of water collected during the investigation of the proposed sources of supply may be found on page 236 of the annual report for 1895.

WATER SUPPLY OF NAHANT.

(See *Swampscott.*)

WATER SUPPLY OF NANTUCKET. — WANNACOMET WATER COMPANY.

Chemical Examination of Water from Wannacomet Pond, Nantucket.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15656	Jan. 7	Slight.	Slight.	.06	6.10	1.30	.0004	.0130	.0108	.0022	2.29	.0030	.0000	.10	1.3
16024	Feb. 4	V. slight.	V. slight.	.03	6.05	2.26	.0006	.0168	.0142	.0026	2.22	.0000	.0000	.19	1.4
16204	Mar. 6	Distinct.	Slight.	.04	6.16	1.65	.0000	.0124	.0100	.0024	2.23	.0000	.0000	.11	1.1
16369	Apr 6	Distinct.	Slight, white.	.08	6.10	1.50	.0000	.0144	.0098	.0046	1.87	.0080	.0001	.12	1.4
16610	May 15	Slight.	Cons., yellow.	.02	6.05	1.70	.0038	.0132	.0116	.0016	2.22	.0050	.0000	.09	1.6
16724	June 2	Distinct.	Slight, rusty.	.10	6.00	1.70	.0016	.0166	.0144	.0022	2.21	.0000	.0000	.14	1.7
16948	July 7	V. slight.	V. slight.	.10	6.25	1.85	.0004	.0120	.0108	.0012	2.00	.0050	.0000	.16	1.1
17130	Aug 4	V. slight.	Slight, brown.	.05	5.90	2.15	.0006	.0126	.0106	.0020	2.40	.0070	.0000	.14	1.5
17366	Sept. 2	Slight.	Slight.	.20	6.15	1.35	.0010	.0124	.0106	.0018	2.10	.0020	.0000	.09	1.6
17601	Oct. 6	Slight.	Slight, brown.	.05	6.55	1.20	.0004	.0180	.0152	.0028	2.22	.0030	.0000	.18	1.7
17796	Nov. 3	V. slight.	Slight.	.05	6.35	1.25	.0004	.0116	.0110	.0006	2.30	.0080	.0000	.12	1.7
17997	Dec. 2	Slight.	Slight.	.02	6.25	1.30	.0002	.0114	.0078	.0036	2.31	.0020	.0000	.07	1.5

Averages by Years.

-	1887*	-	-	.08	4.72	1.20	.0002	.0176	-	-	2.20	.0020	-	-	-
-	1888†	-	-	.05	5.98	0.95	.0002	.0153	-	-	2.11	.0048	.0002	-	-
-	1889‡	-	-	.10	-	-	.0031	.0416	.0269	.0147	1.99	.0037	.0001	-	-
-	1890§	-	-	.00	-	-	.0006	.0188	.0127	.0061	1.95	.0025	.0000	-	-
-	1891‖	-	-	.22	7.54	2.33	.0112	.0588	.0317	.0271	1.86	.0076	.0001	-	1.4
-	1892¶	-	-	.03	6.84	1.68	.0004	.0136	.0111	.0025	2.22	.0033	.0000	-	1.6
-	1893‖	-	-	.22	7.00	2.02	.0013	.0469	.0208	.0261	2.08	.0025	.0000	.22	1.6
-	1894**	-	-	.05	6.74	1.65	.0015	.0131	.0108	.0023	2.30	.0000	.0000	.12	1.6
-	1895	-	-	.06	6.41	1.57	.0008	.0146	.0119	.0027	2.14	.0024	.0000	.14	1.6
-	1896	-	-	.06	6.24	1.57	.0008	.0137	.0114	.0023	2.20	.0027	.0000	.13	1.5

* July to November. † February to May. ‡ September to November. § March and April. ‖ August to December. ¶ May to October. ** June to December.

NOTE to analyses of 1896: Odor, generally distinctly vegetable, occasionally fishy, frequently none. — The samples were collected as follows: Nos. 15656, 16024 and 16204, from the reservoir; No. 16948, from the distributing tank; the remaining samples, from the pond.

NANTUCKET.

Microscopical Examination of Water from Wannacomet Pond, Nantucket.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	9	6	10	8	19	4	9	6	5	3	5	5
Number of sample,	15856	16024	16204	16369	16610	16724	16946	17130	17366	17591	17786	17997
PLANTS.												
Diatomaceæ,	313	146	1,120	237	100	7	3	3	2	6	21	14
Asterionella,	7	0	0	0	0	0	0	0	0	0	0	0
Cyclotella,	0	0	0	0	0	0	0	0	0	0	14	2
Navicula,	0	0	0	1	24	3	0	0	0	1	2	4
Synedra,	306	146	1,120	236	36	1	3	3	2	5	5	8
Tabellaria,	0	0	0	0	40	3	0	0	0	0	0	0
Algæ, Protococcus,	0	0	0	0	5	0	0	4	0	0	0	0
ANIMALS.												
Rhizopoda, Difflugia,	2	0	0	0	0	0	0	0	0	0	0	0
Infusoria,	65	13	1,243	577	246	0	0	2	1	2	154	108
Ceratium,	0	0	0	0	0	0	0	2	0	0	0	0
Dinobryon,	64	11	1,240	552	244	0	0	0	0	2	154	108
Peridinium,	1	2	2	24	2	0	0	0	0	0	0	0
Trachelomonas,	0	0	1	1	0	0	0	0	1	0	0	0
Vermes,	3	0	0	5	0	0	0	2	1	0	0	0
Anuræa,	3	0	0	0	0	0	0	0	0	0	0	0
Polyarthra,	0	0	0	2	0	0	0	2	1	0	0	0
Rotatorian ova,	0	0	0	3	0	0	0	0	0	0	0	0
Crustacea, Cyclops,	0	0	0	0	.02	0	0	0	0	0	0	0
Miscellaneous,	0	0	20	10	60	10	0	20	10	15	10	0
Acarina,	.04	0	0	10	0	0	0	.02	0	0	0	0
Zoöglœa,	0	0	20	0	60	10	0	20	10	15	10	0
TOTAL,	405	159	2,383	819	411	17	3	31	14	23	185	122

Water Supply of Natick.

Chemical Examination of Water from Dug Pond, Natick.

[Parts per 100,000.]

Number.	[redacted] of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1896.														
15840	Jan. 6	Slight.	Slight.	.15	6.25	1.65	.0060	.0184	.0142	.0042	.86	.0450	.0002	.28	[redacted]
16010	Feb. 3	Distinct, clayey.	Slight.	.50	6.55	2.65	.0038	.0146	.0112	.0034	.81	.0500	.0004	.30	2.4
16185	Mar. 2	Slight, milky.	Slight.	.28	6.65	1.80	.0028	.0202	.0164	.0038	.84	.0450	.0003	.22	2.8
16353	Apr. 1	Distinct.	Slight.	.12	5.60	1.60	.0078	.0168	.0138	.0030	[redacted]	.0600	.0006	.31	2.1
16535	May 4	Slight.	Slight.	.20	5.90	1.50	.0036	.0190	.0178	.0012	.90	.0880	.0007	.26	2.2
16708	June 1	Slight, milky.	Slight.	.16	6.05	2.30	.0020	.0150	.0128	.0022	.88	.0600	.0001	.22	2.6
16918	July 1	Slight.	Slight.	.08	6.40	1.80	.0012	.0180	.0168	.0012	.88	.0200	.0005	–	2.2
17127	Aug. 4	V. slight.	Slight.	[redacted]	6.95	2.25	.0006	.0196	.0172	.0024	.86	.0080	.0001	.25	2.2
17408	Sept. 8	Slight.	Slight.	.08	6.75	1.75	.0000	.0166	.0106	.0060	.88	.0020	.0000	.15	2.2
17568	Oct. 1	V. slight.	Slight.	.08	5.18	1.00	.0080	.0188	.0166	.0022	.85	.0080	.0000	.22	2.1
17774	Nov. 2	Distinct.	Slight.	.12	6.30	1.65	.0142	.0156	.0138	.0018	.91	.0100	.0000	.19	2.4
17984	Dec. 2	Distinct.	Slight.	.10	5.85	1.10	.0118	.0188	.0148	.0040	.90	.0220	.0000	.20	2.5

Averages by Years.

–	1887*	–	–	.14	5.25	1.21	[redacted]	.0215	–	–	.70	.0050	–	–	–
–	1888	–	–	.12	5.24	1.09	.0070	.0228	–	–	.66	.0197	.0008	–	–
–	1889	–	–	.16	5.55	1.20	.0046	.0242	.0197	.[redacted]	.71	.0292	.0004	–	–
–	1890	–	–	.14	5.66	1.36	.0027	.0199	.0166	.0033	.72	.0227	.0002	–	2.7
–	1891	–	–	.09	5.71	1.45	.0085	.0207	.0167	.0040	.69	.0526	.0003	–	2.4
–	1892	–	–	.06	5.33	1.24	.0068	.0173	.0135	.0038	.72	.0323	.0001	–	2.4
–	1893	–	–	.08	5.25	1.39	.0062	.0192	.0158	.0034	.71	.0193	.0003	.28	2.1
–	1894	–	–	.10	5.64	1.65	.0060	.0155	.0132	.0023	.80	.0218	.0001	.21	2.3
–	1895	–	–	.13	6.27	1.86	.0044	.0191	.0164	.0027	.87	.0312	.0001	.24	2.6
–	1896	–	–	.15	6.19	1.77	.0045	.0176	.0147	.0029	.86	.0290	.0002	.25	[redacted]

* June to December.

Note to analyses of 1896: Odor, generally vegetable, frequently mouldy or unpleasant. —— The samples were collected from a faucet at the pumping station.

NATICK.

Microscopical Examination of Water from Dug Pond, Natick.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	7	5	4	8	5	8	3	6	10	2	4	5
Number of sample,	15840	16010	16185	16363	16535	16708	16918	17127	17403	17568	17774	17994
PLANTS.												
Diatomaceæ,	1,792	1,850	38	63	97	39	120	31	23	58	960	2,604
Asterionella,	1,360	0	26	30	8	3	8	0	2	38	58	1,360
Cyclotella,	48	56	0	14	0	0	92	0	0	0	4	0
Diatoma,	0	0	0	0	8	0	0	0	0	0	0	0
Fragilaria,	8	0	0	0	0	0	0	0	0	0	0	0
Melosira,	376	8	0	7	36	5	0	6	21	14	820	1,236
Navicula,	0	0	1	0	2	0	0	1	0	2	4	0
Stephanodiscus,	0	0	8	0	36	7	0	0	0	0	0	0
Synedra,	0	1,764	3	4	0	2	0	24	0	4	74	0
Tabellaria,	0	22	0	8	7	22	20	0	0	0	0	8
Cyanophyceæ,	11	0	3	0	2	5	182	96	12	3	10	0
Clathrocystis,	0	0	0	0	0	0	2	10	0	0	0	0
Microcystis,	3	0	0	0	0	0	0	2	11	3	8	0
Chlorococcus,	8	0	0	0	0	0	0	0	0	0	0	0
Protococcus,	0	0	0	0	0	4	152	80	1	0	0	0
Raphidium,	0	0	3	0	2	1	28	4	0	0	2	0
ANIMALS.												
Infusoria,	12	1	0	4	244	32	6	3	1	104	6	24
Ceratium,	0	0	0	0	0	0	4	3	0	0	0	0
Dinobryon,	11	0	0	2	240	32	0	0	0	100	4	0
Euglena,	0	1	0	1	0	0	0	0	0	0	0	0
Monas,	0	0	0	1	0	0	0	0	0	0	0	12
Peridinium,	1	0	0	0	2	0	2	0	1	2	2	0
Trachelomonas,	0	0	0	0	2	0	0	0	0	2	0	12
Vermes, Anurea,	0	0	0	0	0	0	4	2	0	0	0	0
Crustacea, Cyclops,	0	0	0	.10	.04	0	0	0	0	.02	0	0
Miscellaneous,	20	40	60	15	20	0	0	20	0	30	20	60
Acarina,	0	0	0	0	0	0	.02	0	0	0	0	0
Zoöglœa,	20	40	60	15	20	0	0	20	0	30	20	60
TOTAL,	1,835	1,891	101	82	363	76	312	152	36	195	996	2,688

NATICK.

Table showing Heights of Water in Dug Pond on the First of Each Month in 1896.

[High-water mark is 13.0 feet.]

1896.	Height of Water.	1896.	Height of Water.
	Feet.		Feet.
Jan. 1,	13.00	July 1,	10.50
Feb. 1,	12.83	Aug. 1,	9.33
March 1,	13.42	Sept. 1,	8.09
April 1,	13.83	Oct. 1,	7.93
May 1,	12.92	Nov. 1,	8.25
June 1,	11.58	Dec. 1,	8.75

WATER SUPPLY OF NEEDHAM.

Chemical Examination of Water from the Needham Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1896.												
16960	Apr. 7	None.	None.	.00	6.90	.0000	.0004	1.04	.2100	.0000	.00	2.2	.0020
17582	Oct. 5	None.	None.	.00	6.40	.0000	.0014	0.77	.1050	.0000	.04	1.9	.0000

Averages by Years.

-	1891*	-	-	.00	6.10	.0023	.0022	0.72	.1500	.0000	-	1.7	-
-	1892†	-	-	.00	6.12	.0000	.0001	0.65	.1400	[illegible]	-	2.1	.0072
-	1893	-	-	.00	5.28	.0000	.0007	0.63	.1230	[illegible]	[illegible]	1.9	.0000
-	1894	-	-	.01	5.18	.0013	.0005	0.66	.1367	[illegible]	.01	1.7	.0020
-	1895‡	-	-	.00	6.20	.0000	.0006	0.78	.1[illegible]	[illegible]	.02	1.8	[illegible]
-	1896	-	-	.00	6.65	.0000	.0009	0.90	.1575	.0000	.02	2.0	.0010

* November. † July and August. ‡ April and October.

NOTE to analyses of 1896. Odor of the first sample, faintly earthy; of the last, none. —— The first sample was collected from a faucet at a drinking fountain, and the second from a faucet at the pumping station.

Microscopical Examination.

No organisms.

NEW BEDFORD.

WATER SUPPLY OF NEW BEDFORD.

Chemical Examination of Water from the Conduit of the New Bedford Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
15966	Jan. 28	V. slight.	V. slight.	1.30	6.65	3.40	.0036	.0284	.0256	.0028	.77	.0060	.0000	1.44	1.6
16131	Feb. 24	V. slight.	V. slight.	1.20	5.00	2.15	.0012	.0220	.0204	.0016	.47	.0060	.0001	1.10	1.3
16308	Mar. 23	Slight.	Slight.	0.93	4.35	1.80	.0006	.0148	.0128	.0020	.48	.0070	[redacted]	0.93	1.3
16646	May 6	V. slight.	Cons., rusty.	1.00	4.35	2.45	.0014	.0200	.0172	.0028	.58	.0000	.0000	0.84	1.1
16677	May 26	Slight.	Slight.	1.10	4.35	1.65	.0000	.0242	.0200	.0042	.53	.0300	.0000	0.94	1.1
16865	June 23	Distinct.	Slight.	1.20	4.75	2.40	.0008	.0282	.0272	.0010	.50	.0070	.0001	1.13	0.9
17077	July 28	Slight.	Cons., brown.	1.70	5.75	2.60	.0016	.0316	.0284	.0032	.52	.0070	.0000	1.08	1.0
17317	Aug. 27	V. slight.	Slight.	0.95	4.50	2.00	.0000	.0246	.0218	.0028	.51	.0090	.0000	1.06	0.9
17516	Sept. 21	Slight.	Slight.	0.65	4.40	2.25	.0004	.0286	.0260	.0026	.51	.0060	.0001	0.62	0.8
17688	Oct. 21	V. slight.	Slight.	1.15	5.50	2.95	.0006	.0242	.0228	.0014	.60	.0070	.0003	1.66	1.6
17882	Nov. 23	None.	V. slight.	1.60	6.30	3.80	.0030	.0298	.0272	.0026	.72	.0080	.0001	1.63	1.4
18213	Dec. 29	Slight.	Slight.	1.40	6.95	3.40	.0020	.0264	.0222	.0042	.76	.0090	.0000	1.60	1.8

Averages by Years.

-	1887*	-	-	1.37	5.16	1.95	.0021	.0296	-	-	.56	.0137	-	-	-
-	1888	-	-	1.48	5.19	2.32	.0014	.0254	-	-	.53	.0168	.0001	-	-
-	1889	-	-	1.51	5.06	1.74	.0014	.0241	.0206	.0035	.50	.0102	.0001	-	-
-	[redacted]	-	-	1.46	5.01	2.41	.0015	.0232	.0195	.0037	.45	.0126	.0001	-	1.2
-	1891	-	-	0.95	3.90	1.81	.0006	.0197	.0171	.0026	.42	.0103	.0000	-	0.6
-	1892	-	-	1.10	4.87	2.24	.0006	.0227	.0194	.0033	.52	.0106	.0001	-	1.0
-	1893	-	-	1.36	5.06	2.36	.0022	.0224	.0189	.0035	.51	.0061	.0001	1.04	1.0
-	1894	-	-	1.21	4.80	2.18	.0012	.0194	.0178	.0016	.53	.0068	.0000	0.99	1.0
-	1895	-	-	1.01	4.72	2.21	.0009	.0222	.0198	.0024	.54	.0058	.0000	1.01	1.1
-	1896†	-	-	1.19	5.35	2.56	.0013	.0255	.0230	.0025	.58	.0075	.0001	1.23	1.3

* June to December.

† Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1896: Odor, distinctly vegetable and mouldy. —— The samples were collected from the conduit, at its entrance to the receiving reservoir, and represent water from the storage reservoir. For heights of water, see page 251.

NEW BEDFORD.

Microscopical Examination of Water from the Conduit of the New Bedford Water Works.

[Number of organisms per cubic centimeter.]

	1896. Jan.	Feb.	Mar.	May.	May.	June.	July.	Aug	Sept.	Oct.	Nov.	Dec.
Day of examination,	30	25	24	7	27	24	30	28	22	22	25	31
Number of sample,	15966	16131	16303	16548	16677	16865	17077	17217	17516	17669	17982	18313
PLANTS.												
Diatomaceæ,	12	13	3	6	24	1	6	0	0	2	12	2
Asterionella,	0	13	0	0	0	0	0	0	0	0	6	0
Cyclotella,	10	0	0	0	0	0	0	0	0	0	1	0
Melosira,	0	0	0	0	0	0	6	0	0	0	0	0
Synedra,	2	0	3	6	24	1	0	0	0	2	8	2
Cyanophyceæ, Merismopedia,	0	0	0	0	0	0	0	0	70	0	0	0
Algæ,	4	0	24	0	0	115	4	0	0	0	0	0
Protococcus,	0	0	0	0	0	13	0	0	0	0	0	0
Raphidium,	4	0	4	0	0	2	4	0	0	0	0	0
Staurogenia,	0	0	0	0	0	100	0	0	0	0	0	0
Zoöspores,	0	0	20	0	0	0	0	0	0	0	0	0
ANIMALS.												
Infusoria,	5	14	7	1	4	0	1	0	0	1	2	1
Dinobryon,	0	11	4	0	4	0	0	0	0	0	0	1
Euglena,	0	3	0	0	0	0	0	0	0	0	0	0
Monas,	0	0	0	0	0	0	0	0	0	1	1	0
Peridinium,	5	0	3	0	0	0	0	0	0	0	1	0
Trachelomonas,	0	0	0	1	0	0	1	0	0	0	0	0
Vermes, Asplanchna,	0	2	0	0	[illegible]	0	0	0	0	0	0	0
Miscellaneous,	40	20	3	0	20	10	20	10	0	[illegible]	0	0
Acarina,	0	.02	0	0	0	0	0	0	0	0	0	0
Zoöglœa,	40	20	3	0	20	10	20	10	0	30	0	0
TOTAL,	61	49	37	9	48	126	33	10	70	33	14	3

Chemical Examination of Water from Little Quittacas Pond, Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16606	Apr. 29	Slight.	Slight.	.20	3.10	1.05	.0010	.0176	.0154	.0022	.47	.0070	.0000	.33	0.6
17216	Aug. 27	V. slight.	V. slight.	.22	2.95	1.35	.0000	.0212	.0174	.0038	.52	.0030	.0000	.34	0.5
18310	Dec. 29	Distinct.	V. slight.	.20	3.45	1.40	.0000	.0194	.0142	.0052	.50	.0000	.0000	.41	0.9

NEW BEDFORD.

Chemical Examination of Water from Little Quittacas Pond, Lakeville — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
-	1887*	-	-	.23	2.92	1.16	.0003	.0149	-	-	.51	.0035	-	-	-
-	1888†	-	-	.15	3.00	1.15	.0003	.0171	-	-	.48	.0035	.0001	-	-
-	1893	-	-	.11	3.02	1.23	.0015	.0156	.0128	.0028	.48	.0025	.0000	.29	0.6
-	1894	-	-	.18	2.91	0.95	.0002	.0165	.0137	.0028	.48	.0008	.0000	.21	0.7
-	1895	-	-	.18	3.17	1.25	.0006	.0162	.0137	.0025	.51	.0037	.0000	.31	0.7
-	1896	-	-	.21	3.17	1.27	.0003	.0194	.0157	.0037	.53	.0033	.0000	.35	0.7

* June and September. † January and May.

NOTE to analyses of 1896: Odor, none. —— The samples were collected from the pond. For height of water in this pond, see page 251.

Microscopical Examination.

No. 16506. Diatomaceæ, *Asterionella*, 36; *Melosira*, 4; *Navicula*, 2; *Synedra*, 2. Algæ, *Protococcus*, 9. Vermes, *Anuræa*, 2. Miscellaneous, *Zoöglœa*, 5. Total, 60.

No. 17316. Algæ, *Protococcus*, 220. Crustaceæ, *Cyclops*, .02. Total, 220.

No. 18210. Diatomaceæ, *Asterionella*, 4; *Synedra*, 1. Infusoria, *Trachelomonas*, 5. Miscellaneous, *Zoöglœa*, 5. Total, 15.

Chemical Examination of Water from Great Quittacas Pond, Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16507	Apr. 29	Slight.	Slight.	.57	5.00	1.55	.0006	.0192	.0178	.0014	.46	.0070	.0000	.66	0.7
17315	Aug. 27	V. slight.	V. slight.	.40	3.50	1.60	.0000	.0190	.0160	.0030	.53	.0000	.0000	.69	0.6
18212	Dec. 29	None.	V. slight.	.58	4.35	1.85	.0006	.0212	.0182	.0030	.66	.0020	.0001	.90	0.6

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1893*	-	-	.55	3.62	1.70	.0001	.0152	.0126	.0026	.49	.0010	.0000	.52	0.5
-	1894	-	-	.49	3.30	1.35	.0002	.0154	.0139	.0015	.50	.0017	.0000	.50	0.6
-	1895	-	-	.40	3.30	1.22	.0001	.0154	.0133	.0021	.53	.0020	.0000	.52	0.6
-	1896	-	-	.52	3.82	1.67	.0005	.0198	.0173	.0025	.55	.0030	.0000	.75	0.7

* Five samples, July to September.

NOTE to analyses of 1896: Odor of the first two samples, distinctly vegetable, of the last, none, becoming very faintly vegetable on heating. —— The samples were collected from the pond.

Microscopical Examination.

No. 16507. Diatomaceæ, *Asterionella*, 16; *Navicula*, 2; *Synedra*, 3. Infusoria, *Dinobryon*, 7. Miscellaneous, *Zoöglœa*, 3. Total, 31.

No. 17315. Diatomaceæ, *Asterionella*, 39, *Melosira*, 8. Cyanophyceæ, *Microcystis*, 5. Infusoria, *Mallomonas*, 1; *Peridinium*, 16. Vermes, *Polyarthra*, 1. Total, 70.

No. 18212. Diatomaceæ, *Synedra*, 2. Infusoria, *Peridinium*, 2. Total, 4.

NEW BEDFORD.

Chemical Examination of Water from Long Pond, Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16509	Apr. 29	None.	V. slight.	1.10	3.95	1.95	.0012	.0206	.0194	.0012	.43	.0000	.0000	1.04	0.4
17314	Aug. 27	V. slight.	V. slight.	0.70	3.75	2.00	.0000	.0232	.0198	.0034	.52	.0000	.0000	0.98	0.3
18211	Dec. 29	Slight.	Slight.	1.05	4.80	2.55	.0004	.0218	.0186	.0032	.68	.0020	[illegible]	1.52	0.9

Averages by Years.

-	1891*	-	-	0.56	3.15	1.62	.0000	.0130	.0114	.0016	.49	.0020	.0000	-	0.3
-	1893†	-	-	0.35	3.65	1.92	.0000	.0166	.0144	.0022	.43	.0018	.0000	0.78	0.3
-	1894	-	-	1.00	3.60	1.94	.0002	.0183	.0162	.0021	.47	.0013	.0000	0.90	0.5
-	1895	-	-	0.89	4.07	2.25	.0002	.0190	.0167	.0023	.53	.0010	.0000	0.95	0.5
-	1896	-	-	0.95	4.17	2.17	.0005	.0219	.0193	.0026	.58	.0007	.0000	1.16	0.5

* December, two samples. † July to September, five samples.

Note to analyses of 1896 Odor of the first two samples, vegetable; of the last, none, becoming very faintly vegetable on heating. —— The samples were collected from the pond.

Microscopical Examination.

No. 16509. Diatomaceæ, *Melosira*, 8; *Synedra*, 4. Infusoria, *Dinobryon cases*, 10. Miscellaneous, *Zoöglœa*, 5. Total, 27.

No. 17314. Infusoria, *Peridinium*, 1. Vermes, *Anuræa*, 1. Total, 2.

No. 18211. Diatomaceæ, *Epithemia*, 2; *Fragilaria*, 8; *Synedra*, 1. Total, 11.

Table showing Heights of Water in Acushnet Reservoir and Little Quittacas Pond on the First of Each Month in 1896.

1896.	Acushnet Reservoir. Distance below High-water Mark.	Little Quittacas Pond. Distance below High-water Mark.	[illegible]	Acushnet Reservoir. Distance below High-water Mark.	Little Quittacas Pond. Distance below High-water Mark.
	Feet.	Feet.		Feet.	Feet.
Jan. 1,	0.00	2.83	July 1,	0.42	0.83
Feb. 1,	0.33	2.33	Aug. 1,	1.09	1.17
March 1,	0.00	1.33	Sept. 1,	0.92	2.67
April 1,	0.00	0.25	Oct. 1,	0.25	2.17
May 1,	0.33	0.50	Nov. 1,	0.25	1.50
June 1,	0.67	0.58	Dec. 1,	0.00	[illegible]

NEWBURYPORT.

Water Supply of Newburyport.

Chemical Examination of Water from a Faucet in Newburyport, supplied from the Newburyport Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15905	Jan. 20	V. slight.	V. slight.	.10	5.40	.0002	.0016	0.44	.0200	.0000	.04	2.5	.0220
16071	Feb. 17	Distinct, milky.	Slight.	.15	5.10	.0000	.0044	0.44	.0180	.0000	.05	1.7	.[illegible]
16258	Mar. 16	Distinct, milky.	Slight.	.18	6.10	.0000	.0036	0.48	.0130	.0000	.09	2.2	.0230
16437	Apr. 20	Slight.	Slight.	.18	4.80	.0002	.0050	0.43	[illegible]	.0000	.07	2.1	.0160
16614	May 18	Slight, milky.	Slight.	.22	5.90	.0000	.0022	0.46	.0230	.[illegible]	.06	2.2	.0570
16791	June 15	Slight.	Slight.	.22	5.40	.0002	.0062	0.48	[illegible]	.[illegible]	18	2.2	.0450
17018	July 20	Distinct.	Slight.	.15	6.50	.0004	.0024	0.46	.0200	.0000	[illegible]	2.3	.0280
17219	Aug. 17	Slight, milky.	Slight.	.16	5.60	[illegible]	.0014	0.42	.0200	.0000	[illegible]	2.3	.0490
17473	Sept. 15	Distinct, milky.	Slight.	.15	6.50	.0000	.0010	0.46	.0190	.0000	.03	2.3	[illegible]
17665	Oct. 19	None.	V. slight.	.07	6.90	.0000	.0030	0.48	.0360	.0000	.03	2.7	.0280
17872	Nov. 16	Slight, milky.	Slight.	.07	6.40	.0000	.0004	0.47	.0260	.0000	.02	2.7	.0320
18128	Dec. 15	Decided, clayey.	Slight, earthy.	.23	6.10	.0002	.0016	0.52	.0280	.0000	.02	2.9	.0540

Averages by Years.

-	1887-88*	-	-	.08	5.39	.0004	.0062	0.45	.0212	.0001	-	-	-
-	1893†	-	-	.11	8.50	.0015	.0048	3.44†	.0178	.0000	14	2.7	[illegible]
-	1894	-	-	.13	6.00	.0001	.0039	0.45	.0133	.0000	.09	2.3	.0506
-	1895	-	-	.18	5.96	.0002	.0045	0.61	.0159	.0000	13	2.4	.0302
-	1896	-	-	.16	5.96	.0001	.0029	0.46	.0206	.0000	.06	2.3	.0339

* June, 1887, to May, 1888.

† The very high chlorine present in the water in 1893 was due to the use at times of water from the Merrimack River, which contained a small amount of sea water.

Note to analyses of 1896: Odor, occasionally vegetable, frequently none. —— The samples were collected from a faucet at No. 2 State Street.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 72.

Water Supply of Newton.

Chemical Examination of Water from a Faucet at the Newton Water Works Pumping Station.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1896.												
16075	Feb. 18	None.	None.	.01	4.50	.0000	.0020	.45	.0400	.0000	.02	1.9	.0030
16455	Apr. 22	None.	None.	.00	4.50	.0012	.0030	.37	.0200	.0000	–	1.7	.0040
16782	June 15	Slight.	Slight, rusty.	.02	6.60	.0000	.0006	.38	.0180	.0000	.04	3.1	.0380
17208	Aug. 17	None	None.	.05	5.80	.0008	.0020	.37	[illegible]	[illegible]	.11	2.9	.0090
17656	Oct. 19	V. slight.	V. slight.	.02	7.20	.0010	.0040	.42	[illegible]	[illegible]	.08	2.9	.0060
18106	Dec. 14	None.	V. slight.	[illegible]	5.60	.0010	.0026	.60	.0300	[illegible]	.04	3.0	.0060

Averages by Years.

–	1887*	–	–	.00	4.97	.0005	.0070	.35	.0047	–	–	–	–
–	1888	–	–	.01	4.64	.0009	.0111	.35	.0072	.0001	–	–	–
–	1889	–	–	.01	4.01	.0002	.0061	.30	.0119	.0001	–	–	–
–	1890†	–	–	.00	–	.0000	.0014	.32	.0250	.0001	–	–	–
–	1891†	–	–	.00	4.25	.0002	.0072	.31	.0250	.0000	–	1.8	–
–	1892	–	–	.02	5.13	.0006	.0028	.35	.0190	.0001	–	2.4	.0179
–	1893	–	–	.03	5.08	.0004	.0019	.38	.0194	.0000	.09	2.3	.0119
–	1894	–	–	.03	5.99	.0001	.0021	.40	.0157	.0000	.05	2.7	.0110
–	1895	–	–	.03	5.85	.0001	.0025	.42	.0230	.0000	.06	2.4	.0146
–	1896	–	–	.02	5.70	.0007	.0024	.41	.0260	.0000	.06	2.6	.0108

* June to December. † February.

Note to analyses of 1896: Odor, none. —— The samples were collected from a faucet at the pumping station.

Microscopical Examination.

An insignificant number of organisms was found in sample No. 16782; no organisms were found in the other samples.

NEWTON.

Chemical Examination of Water from the Covered Distributing Reservoir of the Newton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16076	Feb. 18	Slight.	Slight.	.05	6.20	.0000	.0066	.43	.0350	.0000	.10	3.0	.0120
16484	Apr. 22	None.	None.	.00	5.70	.0006	.0028	.39	[illegible]	.0000	–	2.9	.0050
16751	June 15	None.	Slight.	.02	6.30	.0000	.0014	.38	.0250	.0000	.06	3.9	.0020
17209	Aug. 17	V. slight.	Slight.	.07	7.00	.0010	.0044	.40	.0270	.0000	.09	3.5	.0530
17657	Oct. 19	None.	None.	.04	7.40	.0006	.0034	.46	.0140	.0000	.09	2.9	.0060
18109	Dec. 14	None.	None.	.02	6.60	.0006	.0034	.49	.0260	.0000	.06	3.0	.0030

Averages by Years.

–	1892	–	–	.03	6.40	.0022	.0038	.35	.0246	.0003	–	3.0	.0242
–	1893	–	–	.04	6.40	.0000	.0027	.38	.0220	.0000	.07	3.0	.0196
–	1894	–	–	.03	6.44	.0002	.0038	.40	.0149	.0000	.07	2.9	.0352
–	1895	–	–	.03	6.58	.0004	.0037	.43	.0197	.0000	.07	3.2	.0229
–	1896	–	–	.03	6.52	.0006	[illegible]	.42	.0253	.0000	[illegible]	3.2	.0185

NOTE to analyses of 1896: Odor, generally none, occasionally faintly vegetable.—The samples were collected from the reservoir.

Microscopical Examination.

An insignificant number of organisms was found in sample No. 16076; no organisms were found in the other samples

Chemical Examination of Water from the Main Underdrain of the Hyde Brook Division of the Newton Sewerage System.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16413	Apr. 15	Slight.	Slight.	.00	21.40	.0080	.0020	2.12	0.9250	.0007	.08	8.1	.0030
17161	Aug. 11	V. slight.	V. slight.	.00	29.50	.0240	[illegible]	2.53	0.7500	.0025	.08	9.7	.0010
18031	Dec. 9	Decided, clayey.	Heavy, earthy.	.10	22.00	.0286	.0254	2.00	0.5250	.0020	.45	7.8	.2350

NEWTON.

Chemical Examination of Water from the Main Underdrain of the Hyde Brook Division of the Newton Sewerage System — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1891*	-	-	.00	26.05	.0200	.0086	3.15	1.5000	.0050	-	10.7	-
-	1892	-	-	.00	27.06	.0126	.0029	3.18	1.1666	.0015	-	10.1	.0062
-	1893	-	-	.03	25.43	.0140	.0087	2.46	0.9550	.0018	.08	9.4	.0099
-	1894	-	-	.03	26.27	.0106	.0034	2.67	0.9083	.0012	.06	9.2	.0059
-	1895	-	-	.02	25.73	.0072	.0032	2.44	0.5583	.0005	.06	9.7	.0157
-	1896	-	-	.08	24.30	.0202	.0101	2.32	0.7333	.0017	.20	8.5	.0797

* December.

NOTE to analyses of 1896: Odor of the first sample, none; of the second, faintly unpleasant, becoming distinctly vegetable on heating; of the last, distinctly tarry and musty, becoming distinctly disagreeable on heating. —— The samples were collected from the underdrain, at its outlet.

Microscopical Examination.

No. 16412. No organisms.
No. 17161. Fungi, *Crenothrix*, 15. Miscellaneous, *Zoöglœa*, 20. Total, 35.
No. 18031. Miscellaneous, *Zoöglœa*, 400.

Chemical Examination of Water from the Main Underdrain of the Cheesecake Brook Division of the Newton Sewerage System.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
16412	Apr. 15	Slight.	Slight, rusty.	.03	15.90	[illegible]	.0036	1.40	.3000	.0002	.08	6.7	.0340
17163	Aug. 11	Slight	Cons.	.02	16.30	.0044	.0006	1.48	.3250	.0004	.06	7.3	.0240
18029	Dec. 9	Decided, clayey.	Cons., earthy.	.20	18.90	.0108	.0180	1.33	.3750	.0007	.35	6.3	.1020

NEWTON.

Chemical Examination of Water from the Main Underdrain of the Cheesecake Brook Division of the Newton Sewerage System — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1893*	-	-	.08	15.83	.0075	.0016	1.51	.3225	.0006	.02	6.0	.0520
-	1894	-	-	.04	[redacted]	.0265	.0040	2.05	.3567	.0030	.05	7.9	.0340
-	1895	-	-	.03	19.30	.0125	.0038	1.50	.3167	.0004	.03	7.6	.0287
-	1896	-	-	.06	17.03	.0065	.0074	1.40	.3333	.0004	.16	6.8	.0533

* July to December.

Note to analyses of 1896: Odor of the first sample, none; of the second, none, becoming faintly vegetable on heating; of the last, faintly vegetable. —— The samples were collected from the underdrain, at its outlet.

Microscopical Examination.

No. 16412. Fungi, *Crenothrix*, 560.
No. 17163. Fungi, *Crenothrix*, 100. Miscellaneous, *Zoöglœa*, 20. Total, 120.
No. 18029. Fungi, *Crenothrix*, 120. Miscellaneous, *Zoöglœa*, 160. Total, 280.

Chemical Examination of Water from the Main Underdrain beneath the Laundry Brook Valley Sewer, Newton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
16411	Apr. 15	Slight.	Slight, rusty.	.01	19.90	.0152	.0028	2.17	.5300	.0006	.06	7.0	.0440
17162	Aug. 11	Slight.	Slight.	.03	17.50	.0110	.0014	1.71	.3500	.0005	.12	6.7	.0250
18030	Dec. 9	Slight.	Slight, rusty.	.02	17.80	.0092	.0010	1.76	[redacted]	.0003	.04	7.4	.0300

Averages by Years.

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1893*	-	-	.08	16.90	.0082	.0026	1.51	.3500	[redacted]	.08	7.1	.0625
-	1894	-	-	.04	17.23	.0103	[redacted]	1.68	.3767	[redacted]	[redacted]	6.8	.0447
-	1895	-	-	.03	21.70	.0105	.0067	2.09	.6217	.0006	.04	8.5	.0550
-	[redacted]	-	-	.02	18.40	.0118	.0017	1.88	.4600	.0005	.07	7.0	.0330

* October and December.

Note to analyses of 1896: Odor, none; on heating, a faintly vegetable odor was developed in the second sample and a faintly unpleasant odor in the last sample.

Microscopical Examination.

No. 16411. Fungi, *Crenothrix*, 1,184.
No. 17162. Fungi, *Crenothrix*, 80. Miscellaneous, *Zoöglœa*, 10. Total, 90.
No. 18030. Fungi, *Crenothrix*, 240. Miscellaneous, *Zoöglœa*, 20. Total, [redacted]

Water Supply of North Adams.

During the years 1895 and 1896 a reservoir was constructed on Notch Brook, one of the sources of water supply of the city of North Adams. The reservoir was prepared for the storage of water by the removal of soil and vegetable matter from its bottom, and has an area when full of about 12.5 acres and a storage capacity of 90,000,000 gallons. The watershed of the reservoir consists chiefly of steep slopes covered with wood, and is uninhabited.

The advice of the State Board of Health to the board of health of North Adams, relative to the protection of the purity of the Notch Brook supply by the removal of houses on the watershed of the reservoir, may be found on pages 73 and 74 of this volume.

Chemical Examination of Water from Notch Brook Storage Reservoir, North Adams.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16134	Feb. 28	None.	V. slight.	.00	7.15	0.50	.0004	.0066	.0058	.0008	.08	.0100	.0000	.04	6.1
16485	Apr. 27	V. slight.	Cons.	.02	8.55	0.85	.0006	.0050	.0036	.0014	.08	.0080	.0001	.05	5.4
16852	June 22	None.	Slight.	.02	9.50	1.25	.0000	.0050	.0030	.0020	.06	.0030	.0000	.08	6.7
17296	Aug. 24	Distinct.	Slight.	.08	11.50	1.25	.0000	.0064	.0022	.0042	.08	.0000	.0000	.07	9.0
17901	Nov. 16	V. slight	Slight.	.02	7.50	–	.0008	.0044	.0040	.0004	.09	.0020	.0000	.07	7.1
Av.	....	....	....	.03	8.75	0.96	.0004	.0055	.0037	.0018	.08	.0046	.0000	.06	7.3

Odor, none. — The samples were collected from the reservoir.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

NORTH ADAMS.

Chemical Examination of Water from Broad Brook in Pownal, Vermont.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16135	Feb. 23	None.	V. slight.	.12	3.00	0.66	.0004	.0038	.0032	.0006	.06	.0230	.0000	.21	1.0
16454	Apr. 27	V. slight.	V. slight.	.22	3.10	1.06	.0012	.0132	.0106	.0026	.06	.0080	.0001	.32	1.5
16851	June 22	None.	V. slight.	.13	4.16	1.10	.0000	.0048	.0036	.0012	.10	.0100	.0000	.28	2.5
17295	Aug. 24	V. slight.	V. slight.	.40	4.10	1.45	.0000	.0148	.0086	.0062	.04	.0030	.0000	.55	1.9
17900	Nov. 17	V. slight.	V. slight.	.01	4.60	-	.0006	.0054	.0042	.0012	.10	.0070	.0000	.09	4.8
Av.				.19	3.80	1.06	.0004	.0084	.0060	.0024	.07	.0102	.0000	.28	2.5

Odor, none. —— The samples were collected from Broad Brook, at the point where water is taken for the supply of North Adams.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

Chemical Examination of Water from Tubular Wells used as an Auxiliary Supply for North Adams.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
17297	1896. Aug 24	None.	None.	.00	29.70	.0000	.0006	.81	.2500	.0000	.02	23.0	.0000

Odor, none. —— The sample was collected from the pump drawing water from the wells.

Microscopical Examination.

No organisms.

WATER SUPPLY OF NORTHAMPTON.

The advice of the State Board of Health to the city of Northampton, relative to taking an additional water supply from Mill River and its tributaries, may be found on pages 31 to 33 of this volume. The results of analyses of samples of water from Mill River and its tributaries are given under "Williamsburg."

Chemical Examination of Water from Roberts' Meadow Brook, just above the Middle Reservoir of the Northampton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
15968	Jan 28	None.	V. slight.	.18	3.90	1.25	.0002	.0038	.0028	.0010	.10	.0070	.0000	.20	1.7
16155	Feb. 27	V. slight.	V. slight.	.15	3.35	1.10	.0000	.0092	.0086	.0006	.08	.0030	.0000	.21	1.4
16306	Mar. 23	V. slight.	Slight.	.18	3.30	0.95	.0006	.0082	.0072	.0010	.09	.0070	.0000	.30	1.1
16498	Apr. 27	V. slight.	V. slight.	.25	3.45	1.20	.0000	[illegible]	.0072	.0010	.09	.0030	.0002	.31	1.3
16686	May 27	Slight.	Slight.	.20	4.35	0.75	.0004	.0070	.0058	.0012	.09	.0000	.0001	.19	1.6
16869	June 22	V. slight.	Slight.	.25	4.35	1.35	.0020	.0096	.0078	.0018	.08	.0030	.0001	.34	1.5
17096	July 29	V. slight.	Slight.	.20	4.30	1.10	.0018	.0088	.0082	.0006	.10	.0020	.0001	.29	2.1
17319	Aug. 26	V. slight.	Slight.	.20	4.90	0.95	.0014	.0086	.0066	.0020	.11	.0050	.0000	.27	1.7
17555	Sept. 23	Slight.	Slight.	.37	5.40	1.95	.0018	.0180	.0168	.0012	.15	.0080	.0001	.59	1.9
17748	Oct. 28	V. slight.	Slight.	.33	4.65	1.50	.0002	.0118	.0106	.0012	.14	.0000	.0000	.45	1.9
17934	Nov. 23	None.	V. slight	.20	4.35	1.30	.0004	.0068	.0060	.0008	.16	.0020	.0000	.29	1.8
18207	Dec. 29	V. slight.	V. slight.	.07	4.00	0.75	.0000	.0018	.0010	.0008	.12	.0150	.0000	.14	2.5
Av....	1896	....	....	.21	4.11	1.18	.0007	.0085	.0074	.0011	.11	.0042	.0000	.30	1.7
Av....	1895*	....	....	.36	4.72	1.46	.0005	.0132	.0112	.0020	.14	.0032	.0001	.45	1.9

* August to December.

NOTE to analyses of 1896: Odor, faintly vegetable or none. —— The samples were collected from the stream, just above the reservoir.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 21.

NORTHAMPTON.

Chemical Examination of Water from the Middle Storage Reservoir of the Northampton Water Works on Roberts' Meadow Brook, collected near the Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15969	Jan. 28	None.	V. slight.	.13	3.75	1.45	.0004	.0040	.0032	.0008	.10	.0050	.0000	.21	1.8
16158	Feb. 27	Slight.	Slight.	.22	2.50	0.55	.0000	.0068	.0060	.0008	.07	.0130	.0000	.24	1.5
16307	Mar. 23	V. slight.	Slight.	.20	2.35	1.05	.0012	.0112	.0076	.0036	.06	.0070	.0000	.34	1.1
16499	Apr. 27	V. slight.	V. slight.	.30	3.45	1.30	[illegible]	.0116	.0066	.0050	.06	.0070	.0002	.34	1.3
16684	May 27	V. slight.	None.	.22	3.65	0.95	.0000	.0110	.0070	.0040	.07	.0000	.0001	.24	1.7
16870	June 22	Distinct.	Slight.	.27	4.15	1.40	.0002	.0142	.0114	.0028	.06	.0030	.0001	.43	1.8
17097	July 29	Slight.	Slight.	.20	3.65	1.10	.0010	.0164	.0108	.0056	.10	.0000	.0000	.30	1.8
17330	Aug. 26	Slight.	Slight.	.25	4.55	1.30	.0000	.0146	.0116	.0030	.10	.0030	.0000	.33	2.1
17556	Sept. 28	Slight.	None.	.37	4.90	1.85	.0012	.0236	.0166	.0070	.14	.0000	.0000	.53	1.7
17749	Oct. 23	V. slight.	Slight.	.37	4.60	1.70	.0008	.0148	.0124	.0024	.14	.0020	.0000	.51	2.0
17935	Nov. 23	V. slight.	V. slight.	.35	4.50	1.55	.0004	[illegible]	.0108	.0014	.16	.0020	.0001	.45	1.7
18206	Dec. 29	Slight.	Slight.	.13	4.20	1.30	.0000	.0058	.0048	.0010	.14	.0150	.0000	.22	2.0
Av....	1896	....	....	.25	3.89	1.37	.0004	.0121	.0092	[illegible]	.10	.0047	.0000	.34	1.7
Av....	1895*	....	....	.37	4.56	1.72	.0008	.0181	.0156	.0025	.13	.0024	.0000	.61	1.8

* June to December.

Note to analyses of 1896: Odor, vegetable or none. The iron was determined in these samples, the average amount being .0152 parts per 100,000. —— The samples were collected from the reservoir, at depths of from 6 inches to 1 foot beneath the surface.

NORTHAMPTON.

Microscopical Examination of Water from the Middle Storage Reservoir of the Northampton Water Works on Roberts' Meadow Brook, collected near the Surface.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	30	28	25	30	29	24	31	28	25	30	25	30
Number of sample,	15969	16156	16307	16499	16684	16870	17097	17320	17556	17749	17935	18206
PLANTS.												
Diatomaceæ,	9	1	0	80	165	125	188	1	288	98	44	4
Cyclotella,	1	0	0	0	120	2	80	0	204	44	0	0
Cymbella,	0	0	0	3	1	1	0	0	4	0	0	1
Eunotia,	0	0	0	32	1	0	0	0	0	0	0	0
Melosira,	0	0	0	14	0	0	0	0	0	0	0	0
Navicula,	2	0	0	4	5	2	0	1	2	2	0	0
Pinnularia,	0	0	0	0	0	0	0	0	0	0	6	0
Synedra,	6	1	0	6	32	120	108	0	78	52	10	1
Tabellaria,	0	0	0	21	6	0	0	0	0	0	28	2
Cyanophyceæ, Merismopedia,	0	0	0	0	0	0	0	0	10	0	0	0
Algæ,	0	0	0	0	0	18	0	0	20	254	328	0
Protococcus,	0	0	0	0	0	0	0	0	20	0	0	0
Scenedesmus,	0	0	0	0	0	18	0	0	0	254	328	0
ANIMALS.												
Infusoria,	0	0	0	0	0	10	72	6	27	21	0	0
Dinobryon,	0	0	0	0	0	9	48	0	20	18	0	0
Codonella,	0	0	0	0	0	0	0	1	0	3	0	0
Mallomonas,	0	0	0	0	0	0	0	0	2	0	0	0
Peridinium,	0	0	0	0	0	1	23	4	1	0	0	0
Phacus,	0	0	0	0	0	0	0	0	2	0	0	0
Tintinnidium,	0	0	0	0	0	0	0	0	2	0	0	0
Trachelomonas,	0	0	0	0	0	0	1	1	0	0	0	0
Vermes,	0	0	0	0	0	1	0	6	1	0	10	0
Anurea,	0	0	0	0	0	1	0	6	0	0	0	0
Asplanchna,	0	0	0	0	0	0	0	0	0	0	2	0
Rotatorian ova,	0	0	0	0	0	0	0	0	0	0	6	0
Rotifer,	0	0	0	0	0	0	0	0	1	0	2	0
Crustacea, Cyclops,	0	0	0	0	0	0	0	0	0	.02	0	0
Miscellaneous,	10	0	0	0	40	7	60	10	10	20	20	0
Acarina,	0	0	0	0	0	.02	.02	0	0	0	0	0
Zoöglea,	10	0	0	0	40	7	60	10	10	20	20	0
TOTAL,	19	1	0	80	205	161	320	23	356	403	402	4

NORTHAMPTON.

Chemical Examination of Water from the Middle Storage Reservoir of the Northampton Water Works on Roberts' Meadow Brook, collected near the Bottom.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
15970	Jan. 28	V. slight.	Slight.	0.30	3.95	1.45	.0026	.0108	.0066	.0042	.10	.0100	.0000	0.34	1.7
16157	Feb. 27	Distinct, clayey.	Slight.	0.30	3.15	1.05	.0044	.0104	.0090	[illegible]	.08	.0120	.0000	0.32	1.3
16306	Mar. 23	Slight, clayey.	Slight.	0.20	2.10	0.70	.0004	.0098	.0070	.0028	.06	.0070	[illegible]	0.23	1.0
16500	Apr. 27	Distinct.	Cons., brown.	0.35	3.50	1.15	.0015	.0126	.0106	.0020	.08	.0050	.0002	0.42	1.2
16685	May 27	Slight.	Cons., brown.	0.33	4.25	1.20	.0024	.0166	.0084	.0082	.08	.0000	.0001	0.35	1.7
16871	June 22	Distinct.	Cons., rusty.	0.65	4.55	1.25	.0020	.0180	.0088	.0092	.05	.0050	.0000	–	1.9
17096	July 29	Distinct.	Cons., rusty.	2.30	6.15	1.80	.0344	.0228	.0150	.0078	.10	.0030	.0000	0.54	2.4
17321	Aug. 26	Distinct.	Cons.	3.00	7.30	1.95	.0852	.0302	.0214	.0088	.10	.0000	.0000	0.70	3.0
17557	Sept. 23	Slight.	Cons., rusty.	2.60	9.15	3.05	.0638	.0378	.0250	.0128	.11	.0000	.0000	1.72	3.5
17750	Oct. 28	V. slight.	Slight.	0.37	4.90	1.70	.0006	.0148	.0128	.0020	.14	.0000	.0000	0.49	1.9
17936	Nov. 23	V. slight.	Slight.	0.23	4.50	1.55	.0008	.0138	.0102	.0036	.16	.0050	.0001	0.46	1.8
18209	Dec. 29	V. slight.	Slight.	0.22	4.15	1.40	.0006	.0076	.0064	.0012	.14	.0070	.0001	0.31	1.9
Av..	1896	....	....	0.90	4.85	1.54	.0124	.0171	.0118	.0053	.10	.0045	.0000	0.54	1.9
Av..	1895*	....	....	1.86	6.27	2.14	.0150	.0247	.0182	.0065	.14	.0038	.0000	0.69	2.0

* August to December.

Note to analyses of 1896: Odor in January and December, none; in November, none, becoming faintly vegetable on heating; at other times, vegetable and occasionally unpleasant or disagreeable. The iron was determined in all the samples, the average amount being .3781 parts per 100,000.

Microscopical Examination of Water from the Middle Storage Reservoir of the Northampton Water Works on Roberts' Meadow Brook, collected near the Bottom.

[Number of organisms per cubic centimeter.]

	1896. Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec
Day of examination,	30	28	25	30	29	24	31	29	25	30	25	30
Number of sample,	15970	16157	16306	16500	16685	16871	17096	17321	17557	17750	17936	18209
PLANTS.												
Diatomaceae,	5	9	5	102	136	11	60	2	362	60	42	13
Cyclotella,	0	0	0	0	100	0	40	0	312	11	0	0
Cymbella,	0	0	0	4	1	0	0	0	0	0	4	0
Eunotia,	0	0	0	10	2	0	0	0	0	2	0	0
Melosira,	0	0	0	18	0	0	0	0	0	0	0	0
Navicula,	1	2	1	20	2	0	0	1	2	7	2	0
Synedra,	4	7	4	8	28	7	20	1	48	36	36	12
Tabellaria,	0	0	0	42	3	4	0	0	0	4	0	1

NORTHAMPTON.

Microscopical Examination of Water from the Middle Storage Reservoir of the Northampton Water Works on Roberts' Meadow Brook, collected near the Bottom — Concluded.

[Number of organisms per cubic centimeter.]

	1896. Jan.	Feb.	Mar.	Apr.	May	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.
PLANTS — Con.												
Cyanophyceæ, Microcystis,	0	0	0	0	0	6	3	2	24	0	0	0
Algæ,	0	0	0	0	1	29	1	0	14	288	124	[illegible]
Raphidium,	0	0	0	0	0	0	0	0	14	0	0	0
Scenedesmus,	0	0	0	0	1	29	1	0	0	288	124	0
Fungi, Crenothrix,	2	8	1	0	0	706	8	0	8	0	0	0
ANIMALS.												
Infusoria,	0	0	0	0	0	0	43	0	4	1	2	0
Codonella,	0	0	0	0	0	0	3	0	0	1	2	0
Dinobryon,	0	0	0	0	0	0	40	0	4	0	0	0
Vermes, Rotatorian ova,	0	0	0	0	0	0	0	0	0	0	2	[illegible]
Miscellaneous, Zoöglœa,	80	0	20	0	0	40	0	0	[illegible]	5	10	[illegible]
TOTAL,	87	9	26	102	187	788	107	4	444	354	180	12

Chemical Examination of Water from Roberts' Meadow Brook, just below the Lower Reservoir of the Northampton Watcr Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
16064	1896. Feb.11	Distinct.	Slight, earthy.	.33	3.00	1.25	.0000	.0102	.0084	.0018	.08	.0050	.0000	.39	0.8

Odor, faintly vegetable, becoming distinctly vegetable and mouldy on heating. —— The sample was collected from Roberts' Meadow Brook, at the first bridge below the lower reservoir.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

NORTH ATTLEBOROUGH.

WATER SUPPLY OF NORTH ATTLEBOROUGH.

Chemical Examination of Water from the Wells of the North Attleborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16080	Feb. 17	None.	None.	.00	6.20	.0000	.0012	.62	.0420	.0000	.03	2.5	.0030
16444	Apr. 20	None.	None.	.00	6.50	.0006	.0014	.68	.0600	.0000	.02	2.5	.0050
16786	June 14	None.	None.	.05	6.30	.0000	.0006	.74	.0500	[redacted]	.04	2.9	.0010
17245	Aug. 18	None.	None.	.02	7.00	.0000	.0000	.67	.0380	[redacted]	[redacted]	3.1	.0000
17664	Oct. 19	None.	None.	.06	8.10	.0002	.0006	.68	.0200	.0000	.02	3.6	.0280
18130	Dec. 16	Slight, milky	V. slight.	.08	6.50	.0004	.0004	.70	.0320	.0001	.03	4.0	.0290

Averages by Years.

-	1887*	-	-	.00	6.28	.0001	.0011	.50	.0290	-	-	-	-
-	1888	-	-	.00	6.27	.0002	.0015	.50	.0258	.0000	-	-	-
-	1889†	-	-	.00	6.09	.0000	.0012	.55	.0414	.0000	-	-	-
-	1892‡	-	-	.00	5.95	.0008	.0018	.53	.0416	.0000	-	3.0	.0156
-	1893§	-	-	.00	5.82	.0008	.0008	.60	[redacted]	[redacted]	.01	2.8	.0040
-	1894	-	-	.04	6.64	.0009	.0010	.70	.0508	.0001	.02	3.1	.0178
-	1895	-	-	.01	6.61	.0005	.0014	.65	.0452	.0000	.02	2.9	.0020
-	1896	-	-	.03	6.77	.0002	.0007	.68	.0387	[redacted]	.03	3.1	.0127

* June to December. † January to May. ‡ April to December. § March and July.

NOTE to analyses of 1896: Odor, none. —— The samples were collected from a faucet at the pumping station.

Microscopical Examination.

No organisms.

WATER SUPPLY OF NORTHBOROUGH.

Chemical Examination of Water from the Upper Reservoir of the Northborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
16129	Feb. 24	Slight, clayey.	Slight.	0.60	3.30	1.10	.0024	.0150	.0114	[illegible]	.17	.0180	.0001	0.54	1.3
16506	Apr. 29	Slight.	Slight.	1.25	3.25	[illegible]	.0018	.0238	.0224	.0014	.14	.0030	.0000	0.92	0.9
16887	June 24	Slight.	Slight.	1.60	4.60	2.50	.0008	.0310	.0288	.0022	.12	[illegible]	[illegible]	1.59	0.9
17270	Aug. 24	Distinct.	Slight.	0.70	4.05	1.95	.0006	.0270	.0254	.0016	.24	[illegible]	.0001	0.76	[illegible]
17721	Oct. 26	V. slight.	V. slight.	1.00	4.80	2.15	.0008	.0212	.0194	.0018	.29	[illegible]	.0001	1.13	0.8

Averages by Years.

–	1893*	–	–	1.00	3.92	1.80	.0001	.0226	.0193	.0033	.26	.0075	.0000	0.78	1.0
–	1894†	–	–	0.70	4.42	2.22	.0004	.0413	.0221	.0192	.30	.0020	.0000	0.69	0.9
–	1895‡	–	–	0.87	3.15	1.35	.0004	.0200	.0180	.0020	.11	.0050	.0000	0.70	0.5
–	1896	–	–	1.08	4.00	1.86	.0013	.0236	.0215	.0021	.19	.0044	.0001	0.99	0.9

* May and September. † July and August. ‡ December.

NOTE to analyses of 1896: Odor, distinctly vegetable and mouldy.—The samples were collected from the reservoir.

Microscopical Examination of Water from the Upper Reservoir of the Northborough Water Works.

[Number of organisms per cubic centimeter.]

	1896.				
	February.	May.	June.	August.	October.
Day of examination,	25	1	25	25	27
Number of sample,	16129	16506	16887	17270	17721
PLANTS.					
Diatomaceæ,	5	90	29	13	11
Cyclotella,	0	2	6	0	0
Epithemia,	2	6	0	0	0
Fragilaria,	0	82	0	1	0
Navicula,	1	2	0	0	1
Synedra,	2	40	10	11	5
Tabellaria,	0	8	13	1	5
Algæ,	0	0	14	1	6
Closterium,	0	0	3	0	0
Protococcus,	0	0	[illegible]	1	6

NORTHBOROUGH.

Microscopical Examination of Water from the Upper Reservoir of the Northborough Water Works — Concluded.

[Number of organisms per cubic centimeter.]

	1896. February.	1896. May.	1896. June.	1896. August.	1896. October.
ANIMALS.					
Infusoria,	0	0	23	1	1
Codonella,	0	0	1	0	0
Dinobryon,	0	0	20	0	0
Euglena,	0	0	0	0	1
Monas,	0	0	2	0	0
Trachelomonas,	0	0	0	1	0
Vermes,	0	0	5	0	0
Rotatorian ova,	0	0	3	0	0
Rotifer,	0	0	2	0	0
Miscellaneous, Zoöglœa,	[illegible]	40	5	5	[illegible]
TOTAL,	5	130	76	20	12

Chemical Examination of Water from the Lower Reservoir of the Northborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16130	Feb. 24	Slight, clayey.	Slight.	0.55	3.40	1.00	.0064	.0166	.0152	.0014	.17	.0130	.0001	0.53	0.6
16506	Apr 29	Distinct.	Slight.	1.00	3.20	1.45	.0004	.0234	.0220	.0014	.13	.0070	.0000	0.77	1.0
16888	June24	Distinct.	Slight.	1.00	3.95	1.85	.0014	.0274	.0232	.0042	.12	.0030	.0000	1.05	0.8
17271	Aug.24	Distinct.	Cons.	0.52	3.70	1.70	.0000	.0270	.0230	.0040	.20	.0000	.0000	0.65	0.7
17722	Oct. 26	V. slight.	Slight.	0.90	4.35	1.95	.0008	.0248	.0234	.0014	.26	.0000	.0001	1.05	0.9

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1893*	-	-	0.40	4.60	1.95	.0000	.0276	.0156	.0120	.28	.0050	.0000	0.49	0.9
-	1894†	-	-	0.57	3.20	1.52	.0009	.0337	.0218	.0119	.27	.0000	.0000	0.54	0.9
-	1895	-	-	0.70	3.62	1.58	.0002	.0218	.0180	.0038	.20	.0020	.0000	0.72	0.7
-	1896	-	-	0.79	3.72	1.59	.0018	.0238	.0213	.0025	.18	.0046	.0000	0.81	0.8

* September. † July and August.

Note to analyses of 1896 Odor, vegetable, becoming somewhat stronger on heating. —— The samples were collected from the reservoir.

NORTHBOROUGH.

Microscopical Examination of Water from the Lower Reservoir of the Northborough Water Works.

[Number of organisms per cubic centimeter.]

	1896.				
	February.	May.	June.	August.	October.
Day of examination,	25	1	25	25	27
Number of sample,	16130	16506	16888	17271	17722
PLANTS.					
Diatomaceæ,	4	292	1,000	1,330	122
Asterionella,	0	10	464	232	26
Diatoma,	0	0	0	14	0
Fragilaria,	3	14	0	0	0
Melosira,	0	16	22	432	54
Meridion,	0	0	0	4	2
Synedra,	1	220	226	628	18
Tabellaria,	0	32	288	20	22
Cyanophyceæ,	0	18	4	2	0
Microcystis,	0	0	4	2	0
Oscillaria,	0	18	0	0	0
Algæ,	0	24	28	62	6
Pediastrum,	0	2	4	2	0
Protococcus,	0	4	6	0	0
Raphidium,	0	6	8	40	2
Scenedesmus,	0	0	10	0	4
Sphærozosma,	0	6	0	0	0
Staurastrum,	0	0	0	20	0
Zoöspores,	0	6	0	0	0
ANIMALS.					
Rhizopoda, Actinophrys,	0	0	0	0	2
Infusoria,	0	2	62	104	0
Codonella,	0	0	0	16	0
Dinobryon,	0	0	56	70	0
Mallomonas,	0	0	0	4	0
Monas,	0	2	4	0	0
Peridinium,	0	0	0	12	0
Tintinnidium,	0	0	0	2	0
Trachelomonas,	0	0	2	0	0
Vermes,	0	2	42	4	0
Anuræa,	0	0	2	2	0
Rotifer,	0	2	40	2	0
Crustacea,	0	.02	0	0	.02
Cyclops,	0	0	0	0	.02
Daphnia,	0	.02	0	0	0
Miscellaneous,	0	60	10	100	5
Acarina,	0	0	0	.16	0
Zoöglœa,	0	60	10	100	5
TOTAL,	4	398	1,146	1,602	135

NORTH BROOKFIELD.

WATER SUPPLY OF NORTH BROOKFIELD.

Chemical Examination of Water from Doane Pond, North Brookfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15929	Jan. 22	Decided, clayey.	Slight.	.38	4.65	1.60	.0040	.0176	.0164	.0016	.17	.0100	.0000	.45	1.1
16105	Feb. 19	Distinct, clayey.	Slight.	.40	3.90	1.25	.0034	.0202	.0190	.0012	.11	.0160	.0001	.48	1.1
16280	Mar. 18	Decided.	Slight.	.46	3.65	1.55	.0012	.0254	.0212	.0042	.15	.0130	.0000	.52	1.1
16462	Apr. 22	Decided.	Slight.	.30	2.85	1.10	.0002	.0256	.0176	.0080	.11	.0070	.0000	[illegible]	0.9
16634	May 20	Decided.	Cons., yellow.	.40	3.70	1.65	.0010	.0352	.0244	.0108	.16	.0050	.0000	.45	1.0
16806	June 17	Decided, green.	Slight.	.47	3.55	1.90	.0002	.0286	.0262	.0024	.10	.0000	.[illegible]	.55	0.9
17037	July 22	Slight.	Slight.	.55	3.50	1.75	.0018	.0324	.0304	.0020	.14	.0030	.0000	.49	1.3
17247	Aug. 19	Slight.	Cons.	.68	3.55	1.60	.0000	.0344	.0332	.0012	.18	.0050	.0000	[illegible]	1.5
17513	Sept. 21	Distinct.	Slight.	.40	3.75	1.60	.0000	.0440	.0392	.0048	.18	.0000	.0002	.40	0.8
17668	Oct. 20	Distinct.	Slight.	.38	3.70	1.05	.0022	.0342	.0282	.0060	.16	.0050	.0000	.45	1.3
17890	Nov. 18	Distinct.	Slight.	.40	4.15	[illegible]	.0002	.0246	.0226	.0020	[illegible]	.0000	.0001	.51	1.2
18137	Dec. 16	Distinct.	Slight.	.35	3.65	1.55	.0004	.0230	.0198	.0032	.20	.0020	.0001	.52	0.9

Averages by Years.

-	1894	-	-	.91	4.24	1.77	.0110	.0353	.0280	.0073	.19	.0054	.0001	.62	1.1
-	1895	-	-	.51	4.92	1.60	.0076	.0365	.0285	.0080	.22	.0102	.0002	.51	1.7
-	1896	-	-	.43	3.74	1.48	.0012	.0288	.0247	.0041	.15	.0054	.0000	.51	1.1

NOTE to analyses of 1896: Odor, generally distinctly vegetable, occasionally sweetish. —— The samples were collected from the pond.

NORTH BROOKFIELD.

Microscopical Examination of Water from Doane Pond, North Brookfield.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	23	21	19	24	22	18	23	20	22	21	19	17
Number of sample,	16939	16105	16280	16462	16634	16806	17037	17247	17518	17666	17890	18157
PLANTS.												
Diatomaceæ,	38	[illegible]	28	304	523	122	28	6	70	220	124	42
Asterionella,	17	4	0	64	200	0	0	0	14	196	84	32
Cyclotella,	0	0	2	0	0	0	0	0	0	4	0	0
Melosira,	0	0	0	0	0	0	23	0	0	0	0	0
Navicula,	0	0	0	0	0	1	3	4	0	0	0	0
Synedra,	12	10	17	140	3	32	2	2	44	20	24	4
Tabellaria,	9	0	9	100	320	89	0	0	12	0	16	6
Cyanophyceæ,	0	0	0	0	0	0	0	6	6	0	0	0
Merismopedia,	0	0	0	0	0	0	0	0	6	0	0	0
Microcystis,	0	0	0	0	0	0	0	6	0	0	0	0
Algæ,	2	0	120	0	117	63	15	72	792	18	32	0
Arthrodesmus,	0	0	0	0	1	5	0	0	10	12	4	0
Dictyosphærium,	0	0	0	0	0	0	0	0	0	0	8	0
Pediastrum,	0	0	0	0	0	3	3	4	4	0	0	0
Protococcus,	0	0	0	0	0	11	8	60	728	6	20	0
Raphidium,	2	0	4	0	96	8	0	0	40	0	0	0
Staurastrum,	0	0	0	0	12	6	0	0	2	0	0	0
Staurogenia,	0	0	0	0	8	30	4	8	8	0	0	0
Zoöspores,	0	0	116	0	0	0	0	0	0	0	0	0
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	0	0	2	[illegible]	0	0	0	0	0
Infusoria,	32	43	20	84	28	20	34	10	34	2,122	832	428
Dinobryon,	30	38	15	30	0	14	22	4	8	2,120	820	408
Euglena,	1	0	0	2	0	0	0	0	0	0	0	0
Mallomonas,	0	0	0	0	1	3	0	0	14	0	0	0
Monas,	0	0	0	0	0	2	0	0	6	0	8	0
Peridinium,	1	5	5	0	0	0	2	0	0	2	4	20
Phacus,	0	0	0	0	0	0	0	4	0	0	0	0
Synura,	0	0	0	46	0	0	0	0	6	0	0	0
Tintinnidium,	0	0	0	2	1	0	0	0	0	0	0	0
Trachelomonas,	0	0	0	2	26	1	10	2	6	0	0	0
Uroglena,	0	0	0	2	0	0	0	0	0	0	0	0
Vermes,	0	0	0	12	5	0	0	2	0	0	0	0
Asplanchna,	0	0	0	6	0	0	0	2	0	0	0	0
Polyarthra,	0	0	0	2	5	0	0	0	0	0	0	0
Rotatorian ova,	0	0	0	4	0	0	0	0	0	0	0	0
Miscellaneous,	0	60	4	100	10	20	60	160	20	15	40	10
Acarina,	0	0	0	.02	0	0	.12	0	0	0	0	0
Zoöglœa,	0	60	4	100	10	20	60	160	20	15	40	10
TOTAL,	72	117	172	560	681	227	135	256	924	2,375	1,028	480

NORTH BROOKFIELD.

Chemical Examination of Water from the Filtered-water Well of the North Brookfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15930	Jan. 22	Decided, clayey.	Slight.	.40	4.85	1.60	.0054	.0152	.0140	.0012	.16	.0180	.0000	.62	0.9
16106	Feb. 19	Distinct, clayey.	Slight.	.45	3.70	1.30	.0044	.0210	.0160	.0050	.12	.0160	.0001	.62	0.9
16281	Mar. 18	Decided.	Slight.	.42	2.45	0.75	.0010	.0224	.0140	.0084	.15	.0120	.0000	.52	1.0
16463	Apr. 22	Distinct, green.	Slight.	.30	2.85	1.25	.0002	.0180	.0152	.0028	.12	.0100	.0000	.36	0.7
16635	May 20	Decided.	Cons., yellow.	.40	3.25	1.50	.0006	.0302	.0262	.0040	.16	.0050	.0000	.40	1.0
16807	June 17	Decided, floc.	Cons., yellow.	.30	3.70	1.15	.0136	.0184	.0174	.0010	.12	.0070	.0006	.38	1.1
17028	July 22	V. slight	V. slight.	.57	3.60	1.30	.0006	.0264	.0250	.0014	.14	.0030	[illegible]	.40	1.1
17248	Aug 19	Slight.	Slight.	.68	3.65	1.55	.0000	.0258	.0242	.0016	.12	.0030	.0000	.66	1.4
17514	Sept 21	Distinct.	Slight.	.40	3.65	1.40	.0000	.0332	.0308	.0024	.16	.0050	.0001	.46	0.9
17669	Oct. 20	Distinct.	Slight.	.31	3.70	1.05	.0000	.0232	.0200	.0032	.16	.0030	.0001	.45	1.0
17891	Nov. 18	Distinct.	Slight.	.37	3.95	1.55	.0002	.0212	.0192	.0020	.20	.0050	.0000	.48	1.3
18135	Dec. 16	Distinct.	Slight.	.40	3.60	1.55	.0006	.0198	.0174	.0024	.21	.0020	.0001	.53	0.9

Averages by Years.

-	1894	-	-	.72	4.68	1.86	.0096	.0286	.0252	.0034	.19	.0095	.0002	.54	1.6
-	1895	-	-	.37	5.13	1.50	.0137	.0255	.0196	.0059	.21	.0089	.0001	.37	1.9
-	1896	-	-	.42	3.58	1.37	.0022	.0229	.0200	.0029	.15	.0070	.0001	.48	1.0

NOTE to analyses of 1896: Odor, generally distinctly vegetable, occasionally sweetish, rarely none. —The samples were collected from the filtered-water well in Doane's Pond, from which the supply of the town is drawn.

Microscopical Examination of Water from the Filtered-water Well of the North Brookfield Water Works.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July	Aug.	Sept	Oct.	Nov.	Dec.
Day of examination,	23	21	19	24	22	18	23	20	22	21	19	17
Number of sample,	15930	16106	16281	16463	16635	16807	17038	17248	17514	17669	17891	18135
PLANTS.												
Diatomaceæ,	22	16	32	430	688	0	2	6	128	228	52	44
Asterionella,	0	5	0	14	128	0	0	0	2	208	20	18
Fragilaria,	0	0	0	0	6	0	0	0	0	0	0	0
Navicula,	0	0	0	0	4	0	0	0	2	0	0	0
Synedra,	10	8	24	144	48	0	0	2	116	20	32	2
Tabellaria,	3	3	8	272	500	0	2	4	8	0	0	24

NORTH BROOKFIELD.

Microscopical Examination of Water from the Filtered-water Well of the North Brookfield Water Works — Concluded.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
PLANTS — Con.												
Algæ,	1	[illegible]	48	1	159	0	0	98	676	16	12	2
Arthrodesmus,	0	0	0	0	1	0	0	0	14	6	0	0
Dictyosphærium,	0	0	0	0	0	0	0	0	0	0	12	0
Pediastrum,	0	0	0	1	1	0	0	2	4	0	0	0
Protococcus,	0	0	0	0	1	0	0	92	616	4	0	0
Raphidium,	1	3	4	0	72	0	0	0	22	0	0	2
Staurastrum,	0	0	0	0	20	0	0	4	4	0	0	0
Staurogenia,	0	0	0	0	64	0	0	0	16	3	0	0
Zoöspores,	0	0	44	0	0	0	0	0	0	0	0	0
Fungi, Crenothrix,	0	5	0	0	0	2,000	0	0	0	0	0	0
ANIMALS.												
Infusoria,	3	6	2	11	8	0	329	12	24	516	568	134
Dinobryon,	3	5	0	3	0	0	324	0	4	516	560	124
Mallomonas,	0	0	0	0	0	0	0	0	8	0	0	0
Monas,	0	0	0	0	1	0	0	0	8	0	0	0
Peridinium,	0	1	2	8	0	0	1	2	2	0	8	8
Tintinnidium,	0	0	0	0	1	0	2	0	0	0	0	0
Trachelomonas,	0	0	0	0	6	0	2	10	2	0	0	2
Miscellaneous, Zoöglœa,	0	5	0	40	200	0	40	80	5	15	40	5
TOTAL,	31	35	90	482	1,063	2,000	371	196	838	776	472	185

NORTHFIELD.

The advice of the State Board of Health to the town of Northfield, relative to the protection of the purity of Mill Brook in that town, from which a supply of water for several families is taken, may be found on pages 74 and 75 of this volume.

Chemical Examination of Water from Mill Brook, Northfield.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended		Nitrates.	Nitrites.		
	1896.														
17967	Nov. 27	None.	Slight.	.53	3.50	1.45	.0008	.0148	.0134	.0014	.15	.0030	.0001	.73	0.3
17968	Nov. 27	None.	Slight.	.55	3.85	1.75	.0004	.0154	.0142	.0012	.16	.0050	.0000	.75	0.9

Odor, distinctly vegetable. —— The first sample was collected from Mill Brook, at first road crossing above Main Street, and above the point where the sewage from a hotel enters the stream; the second, from Mill Brook, just above Main Street, at the point where a water supply for several families is taken.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows: No. 17967, 21; No. 17968, 12.

NORWOOD.

WATER SUPPLY OF NORWOOD.

Reference was made in the last annual report to the disagreeable taste and odor in the water from Buckmaster Pond, caused by the organism *Uroglena*. Trouble from this cause continued through the spring of 1897, but ceased early in the summer.

Chemical Examination of Water from Buckmaster Pond, Dedham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15850	Jan. 7	Decided.	Slight.	.18	3.15	1.05	.0066	.0226	.0160	.0066	.24	.0030	.0000	.31	0.5
16020	Feb. 4	Slight.	Slight.	.20	3.35	1.50	.0096	.0176	.0148	.0028	.37	.0020	.0000	.35	0.8
16223	Mar. 10	Decided.	Slight.	.20	3.10	1.20	.0054	.0200	.0140	.0060	.34	.0050	.0001	.31	0.8
16368	Apr. 7	Distinct.	Slight.	.18	2.10	0.60	.0068	.0162	.0140	.0022	.42	.0070	.0001	.28	1.0
16545	May 5	Distinct.	Slight.	.18	2.90	1.45	.0002	.0206	.0174	.0032	.38	.0050	.0000	.33	0.6
16722	June 2	Slight, milky.	Slight.	.23	2.70	1.35	.0016	.0266	.0250	.0016	.34	.0000	.0000	.34	0.8
16940	July 7	Distinct.	Slight.	.15	2.85	0.95	.0000	.0178	.0140	.0038	.38	0070	.0000	-	0.6
17145	Aug. 6	Distinct.	V. slight.	.10	3.05	1.35	.0006	.0196	.0170	.0026	.38	.0000	.0000	.29	0.4
17359	Sept. 3	V. slight.	V. slight.	.13	1.85	0.80	.0004	.0220	.0180	.0040	.38	.0000	.0000	.28	0.3
17588	Oct. 5	V. slight.	Slight.	.07	2.80	1.05	.0090	.0252	.0200	.0052	.40	.0030	.0001	.33	0.3
17779	Nov. 3	Distinct.	V. slight.	.10	3.15	1.05	.0172	.0200	.0184	.0016	.42	.0060	.0000	.23	0.3
17969	Dec. 2	Slight.	Slight.	.08	3.80	0.70	.0038	.0152	.0124	.0028	.40	.0150	.0000	.21	1.7

Averages by Years.

-	1887*	-	-	.09	2.64	1.06	.0058	.0212	-	-	.30	.0018	-	-	-
-	1888	-	-	.15	2.86	0.95	.0069	.0248	-	-	.29	.0065	.0001	-	-
-	1889	-	-	.11	2.47	0.79	.0024	.0199	.0174	.0025	.30	.0068	.0001	-	-
-	1890	-	-	.05	2.59	0.99	.0015	.0180	.0147	.0033	.30	.0075	.0000	-	1.0
-	1891	-	-	[illegible]	2.48	0.97	.0014	.0166	.0140	.0026	.26	.0075	.0000	-	0.7
-	1892	-	-	.07	2.68	1.24	.0019	.0219	.0172	.0047	.32	.0067	.0000	-	0.7
-	1893	-	-	.07	2.62	[illegible]	.0062	.0199	.0156	.0043	.33	.0028	0000	.25	0.7
-	1894	-	-	.10	2.62	1.18	.0055	.0182	.0153	.0029	.36	.0028	.0000	.24	0.5
-	1895	-	-	.16	2.96	1.24	.0047	.0220	.0174	.0046	.36	.0066	.0000	.29	0.5
-	1896	-	-	.15	2.83	1.09	.0048	.0203	.0168	.0035	.37	.0046	.0000	.30	0.7

* June to December.

NOTE to analyses of 1896: Odor of the first four samples, decidedly fishy, of the others, frequently vegetable and occasionally mouldy or unpleasant. —— The samples were collected from the pond.

NORWOOD.

Microscopical Examination of Water from Buckmaster Pond, Dedham.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	6	6	12	6	7	4	3	7	3	7	4	2
Number of sample,	15850	16020	16233	16368	16545	16722	16940	17145	17359	17586	17779	17989
PLANTS.												
Diatomaceæ,	210	44	0	46	27	49	7	0	1	38	122	83
Asterionella,	176	3	0	12	4	0	0	0	0	6	58	74
Cyclotella,	10	0	0	0	14	0	4	0	0	0	20	0
Melosira,	0	10	0	0	0	0	0	0	0	4	30	8
Meridion,	0	12	0	0	0	0	0	0	0	0	0	0
Navicula,	1	7	0	0	0	0	1	0	1	0	2	1
Stephanodiscus,	0	0	0	0	0	48	0	0	0	0	0	0
Synedra,	7	11	0	4	0	1	0	0	0	28	12	0
Tabellaria,	16	1	0	30	9	0	2	0	0	0	0	0
Cyanophyceæ, Microcystis,	0	0	0	0	0	1	4	0	40	6	6	0
Algæ,	58	1	3	0	3	8	21	11	7	6	2	0
Protococcus,	6	1	3	0	3	3	0	4	5	6	2	0
Raphidium,	4	0	0	0	0	5	3	7	2	0	0	0
Ulothrix,	48	0	0	[illegible]	0	0	0	0	0	0	0	0
Zoöspores,	0	0	0	[illegible]	0	0	18	0	0	0	0	0
ANIMALS.												
Infusoria,	204	21	44	20	9	0	1	2	2	2	14	[illegible]
Codonella,	0	0	0	0	0	0	0	0	0	0	2	0
Cryptomonas,	0	0	0	0	7	0	0	0	0	0	0	0
Dinobryon,	1	0	0	0	0	0	0	0	0	0	10	0
Peridinium,	2	1	4	0	1	0	1	2	2	0	2	0
Trachelomonas,	1	0	0	0	1	0	0	0	0	2	0	4
Uroglena,	200	20	40	20	0	0	0	0	0	0	0	0
Vermes,	1	0	0	[illegible]	9	0	0	1	0	0	0	0
Anurea,	0	0	0	0	8	0	0	1	0	0	0	0
Rotifer,	1	0	0	0	1	0	0	0	0	0	0	0
Miscellaneous,	0	0	10	.04	20	0	4	10	5	10	5	20
Acarina,	0	0	0	.04	0	0	0	0	0	0	0	0
Zoöglœa,	0	0	10	0	20	0	4	10	5	10	5	20
TOTAL,	473	66	57	66	68	58	37	24	55	62	149	107

NORWOOD.

Table showing Heights of Water in Buckmaster Pond on the First of Each Month in 1896.

[Distance below crest of dam.]

Date.	Feet.	Date.	Feet.
1896.		1896.	
Jan. 1,	0.92	July 1,	2.71
Feb. 1,	0.06	Aug. 1,	3.33
March 1,	0.42	Sept. 1,	4.75
April 1,	0.38	Oct. 1,	4.67
May 1,	0.17	Nov. 1,	3.75
June 1,	1.08	Dec. 1,	4.67

Water Supply of Orange.

Chemical Examination of Water from North Pond, Orange.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15945	Jan. 21	Slight.	Slight.	.53	3.35	1.50	.0018	.0240	.0218	.0022	.11	.0050	.0000	.59	0.5
16088	Feb. 18	V. slight.	V. slight.	.30	2.90	0.95	.0010	[illegible]	.0074	.0034	.09	.0100	.0000	.33	0.5
16256	Mar. 16	Distinct, clayey.	Cons., earthy.	.23	2.45	1.20	.0020	.0166	.0106	.0060	.14	.0130	.0005	.27	0.6
16414	Apr. 14	V. slight	Slight	.20	2.10	0.70	.0004	.0098	.0076	.0022	10	0000	.0000	22	0.3
16648	May 20	Distinct, green.	Slight, green.	.38	2.55	1.40	.0002	.0232	.0202	.0030	14	.0060	.0000	.46	0.6
16804	June 15	Slight, green.	Cons.	.35	2.46	1.20	.0014	.0260	.0192	.0068	10	.0030	.0000	.56	0.5
16967	July 14	Distinct.	Slight, green.	.48	2.15	1.15	.0022	.0252	.0204	.0048	.09	.0000	.0000	–	0.9
17256	Aug 19	Decided, green.	Slight, green.	.58	3.20	1.90	.0010	.0506	.0472	.0034	.18	.0020	.0000	–	0.8
17486	Sept 16	Distinct, green.	Cons., green.	.48	3.05	2.05	.0000	.0298	.0214	.0084	15	.0020	.0000	.61	0.5
17672	Oct. 20	Distinct.	Slight, green.	.43	3.30	1.30	.0008	.0226	.0180	.0046	.15	.0030	.0000	.61	1.3
17908	Nov. 18	Distinct.	Slight, green.	.30	2.45	1.05	.0000	.0174	.0150	.0024	15	.0020	.0000	.37	1.1
18113	Dec. 14	Slight.	Slight.	.33	2.85	0.90	.0004	.0164	.0126	.0038	.16	.0030	.0001	.30	0.6

Averages by Years.

–	1894	–	–	.67	3.35	1.68	.0012	.0229	.0194	.0035	.13	.0019	.0000	[illegible]	0.6
–	1895	–	–	.72	3.30	1.72	.0028	.0254	.0219	.0035	.14	.0032	[illegible]	.69	0.7
–	[illegible]	–	–	.38	2.77	1.27	.0009	.0225	.0184	.0041	.13	[illegible]	.0000	.44	0.7

Note to analyses of 1896: Odor, vegetable, occasionally sweetish, sometimes none. — The samples were collected from the pond.

ORANGE.

Microscopical Examination of Water from North Pond, Orange.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan	Feb.	Mar	Apr	May	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	24	10	17	16	22	17	16	21	17	21	20	15
Number of sample,	15945	16068	16256	16414	16643	16804	16967	17256	17486	17672	17906	18113
PLANTS.												
Diatomaceæ,	0	25	50	27	2,076	370	316	256	414	96	[illegible]	16
Asterionella,	0	3	8	12	900	66	70	56	344	44	0	5
Cocconeis,	0	0	0	0	0	0	0	0	22	0	0	0
Cymbella,	0	0	2	0	0	0	0	0	0	0	4	0
Epithemia,	0	7	4	0	0	2	0	0	0	0	0	0
Melosira,	0	0	18	0	328	280	88	200	32	46	68	6
Navicula,	0	3	6	2	0	0	0	0	0	2	0	0
Nitzschia,	0	0	2	0	0	0	0	0	0	0	4	0
Synedra,	0	4	8	10	0	6	9	0	14	0	4	5
Tabellaria,	0	3	10	3	848	14	149	0	2	4	32	0
Cyanophyceæ,	0	0	0	0	2	8	2	1,652	30	0	[illegible]	0
Anabæna,	0	0	0	0	0	2	0	1,600	4	0	0	0
Clathrocystis,	0	0	0	0	2	6	1	0	0	0	0	0
Cœlosphærium,	0	0	0	0	0	0	0	0	6	0	0	0
Merismopedia,	0	0	0	0	0	0	0	48	0	0	0	0
Microcystis,	0	0	0	0	0	0	1	4	20	0	0	0
Algæ,	0	1	30	0	25	[illegible]	21	596	1,121	890	952	11
Arthrodesmus,	0	0	0	0	0	10	4	12	10	0	4	2
Chlorococcus,	0	0	0	0	0	0	0	0	1,072	888	944	6
Pediastrum,	0	0	0	0	0	4	1	4	1	0	0	0
Protococcus,	0	0	0	0	25	124	11	0	0	0	0	0
Raphidium,	0	0	0	0	0	24	2	4	28	0	4	3
Spirogyra,	0	0	0	0	0	0	0	568	0	0	0	0
Staurastrum,	0	0	0	0	0	4	2	8	2	2	0	0
Staurogenia,	0	0	0	0	0	0	1	0	8	0	0	0
Zoöspores,	0	1	30	0	0	0	0	0	0	0	0	0
ANIMALS.												
Infusoria,	0	33	2	1	12	2	46	0	21	0	12	1
Dinobryon,	0	1	0	0	1	0	0	0	0	0	0	0
Euglena,	0	0	0	0	0	0	6	0	0	0	0	0
Mallomonas,	0	0	0	0	1	0	0	0	2	0	0	0
Monas,	0	32	0	0	1	2	2	0	8	0	4	0
Paramæcium,	0	0	0	0	0	0	0	0	0	0	8	0
Peridinium,	0	0	0	1	0	0	5	0	0	0	0	0
Raphidomonas,	0	0	0	0	0	0	0	0	4	0	0	0
Synura,	0	0	2	0	2	0	0	0	0	0	0	0
Trachelomonas,	0	0	0	0	2	0	36	0	6	0	0	1
Uroglena,	0	0	0	0	6	0	0	0	1	0	0	0
Vermes,	0	0	0	0	2	0	0	0	4	0	0	0
Anuræa,	0	0	0	0	2	0	0	0	0	0	0	0
Rotatorian ova,	0	0	0	0	0	0	0	0	2	0	0	0
Rotifer,	0	0	0	0	0	0	0	0	2	0	0	0
Crustacea,	0	0	0	0	.02	.04	[illegible]	0	0	0	0	0
Bosmina,	0	0	0	0	.02	0	0	0	0	0	0	0
Cyclops,	0	0	0	0	0	.04	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	0	0	0	0	20	20	5	40	160	40	40	35
Total,	0	59	92	28	2,137	566	392	2,544	1,750	1,026	1,116	66

ORANGE.

Chemical Examination of Water from the Distributing Reservoir of the Orange Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15946	Jan. 21	V. slight.	V. slight.	.22	2.75	0.95	.0000	.0042	[illegible]	.0010	.09	.0070	.0000	.23	0.7
16087	Feb. 18	V. slight.	V. slight.	[illegible]	2.55	0.85	.0000	.0022	.0014	.0008	.11	.0050	.0000	.06	0.5
16257	Mar. 16	None.	Slight.	.02	2.40	0.65	.0000	.0018	.0014	.0004	.12	.0060	.0000	.06	0.6
16415	Apr. 14	Slight.	Slight.	.10	2.50	0.65	.0006	.0034	.0020	.0014	.11	.0000	.0000	.20	0.6
16544	May 20	None.	Slight.	.03	2.95	0.65	.0000	.0020	.0012	.0008	.09	.0080	.0000	[illegible]	0.8
16806	June 15	V. slight.	Slight.	.06	3.06	0.50	.0000	.0028	.0018	.0010	.08	[illegible]	.0000	.10	[illegible]
16988	July 14	None.	Slight.	.10	3.05	0.55	.0000	.0020	.0016	.0004	.06	[illegible]	.0000	.10	0.7
17257	Aug 19	None.	Slight.	.07	3.00	0.60	.0002	.0016	.0014	.0002	.06	.0050	.0000	.09	0.8
17467	Sept. 16	Distinct.	Slight.	.10	3.35	0.60	.0000	.0030	.0024	.0006	.11	[illegible]	.0000	.12	0.8
17673	Oct. 20	None.	V. slight.	.09	3.20	0.75	.0004	.0036	.0028	.0008	.13	.0030	.0000	.14	0.6
17909	Nov. 18	V. slight.	Slight.	[illegible]	2.55	0.60	.0004	.0016	.0012	.0004	.14	.0050	.0000	.06	1.0
18114	Dec. 14	None.	Cons., brown.	.02	2.35	0.30	.0006	.0046	.0022	.0024	.14	.0020	.0000	.08	1.2

Averages by Years.

-	1894	-	-	.52	3.68	1.58	.0007	.0171	.0146	.0025	.14	.0028	.0001	.61	0.8
-	1895	-	-	.22	3.09	[illegible]	.0006	.0103	.0085	.0018	.14	.0047	.0000	.32	0.7
-	1896	-	-	.07	2.80	0.65	.0002	.0027	.0019	.0008	.11	.0036	.0000	.11	0.7

NOTE to analyses of 1896: Odor, generally none, occasionally vegetable. In September a fishy odor was observed. —— The samples were collected from the reservoir.

Microscopical Examination.

An insignificant number of organisms was found in these samples, with the exception of the sample collected in September, in which were found the following organisms: Infusoria, *Dinobryon cases*, 44; *Uroglena*, 8. Total, 52.

Water Supply of Palmer Fire District, Palmer. — Palmer Water Company.

Chemical Examination of Water from the Reservoir of the Palmer Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
17069	July 29	Distinct, green.	Cons., brown.	.35	4.00	1.05	.0016	.0078	.0058	.0020	.11	.0030	.0000	.23	0.9
17352	Sept. 2	Slight.	Cons., earthy.	.27	4.05	1.05	.0004	.0062	.0058	.0014	.10	.0060	.0001	.12	1.1

Odor, vegetable. — The samples were collected from the reservoir.

Microscopical Examination.

No. 17069. Diatomaceæ, *Epithemia*, 2; *Melosira*, 5; *Navicula*, 5; *Pinnularia*, 10; *Synedra*, 1; *Tabellaria*, 1. Miscellaneous, *Zoöglœa*, 60. Total, 84.

No. 17352. Diatomaceæ, *Navicula*, 2, *Pinnularia*, 1; *Synedra*, 3; *Tabellaria*, 2. Infusoria, *Dinobryon*, 135. Vermes, *Anurea*, 1; *Polyarthra*, 1. Miscellaneous, *Zoöglœa*, 20. Total, 165.

Water Supply of Peabody.

The organism *Uroglena* appeared in the water of Brown's and Spring ponds in the early part of 1896, giving the water a disagreeable taste and odor, which was especially noticeable in Spring Pond. The water of these ponds passes into a lower basin before entering the pipe to the town, but no organisms were found in the samples of water collected from this source.

The advice of the State Board of Health to the town of Peabody with reference to the desirability of taking certain lands on the watershed of the lower basin, in order to protect the water from contamination, may be found on page 75 of this volume.

Chemical Examination of Water from Brown's Pond, Peabody.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16212	Mar. 9	Slight.	Slight.	.25	3.10	1.00	.0000	.0160	.0138	.0022	.53	.0020	.0000	.31	0.6
16317	Mar. 24	Distinct.	Slight.	.17	3.40	1.05	.0004	.0136	.0110	.0026	.52	.0100	.0000	.27	1.0
16945	July 6	Slight.	Slight.	.15	2.55	1.00	.0000	.0166	.0140	.0026	.59	.0050	.0000	-	0.5
17847	Nov. 10	V. slight.	Slight.	.05	2.80	1.20	.0004	.0106	.0096	.0010	.64	.0000	.0000	.20	0.6

PEABODY.

Chemical Examination of Water from Brown's Pond, Peabody — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
-	1887*	-	-	.17	3.00	1.05	.0001	.0169	-	-	.46	-	-	-	-
-	1894†	-	-	.16	2.95	1.20	.0018	.0164	.0154	.0010	.53	.0050	.0000	.27	0.5
-	1895	-	-	.16	3.06	1.13	.0013	.0167	.0141	.0026	.56	.0040	.0000	.29	0.6
-	1896‡	-	-	.15	2.97	1.07	.0002	.0140	.0120	.0020	.55	.0037	.0000	.24	0.6

* June, July and August. † September.

‡ Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Note to analyses of 1896: Odor of the first two samples, distinctly fishy; of the third, none; of the last, faintly vegetable. —— The samples were collected from the pond.

Microscopical Examination of Water from Brown's Pond, Peabody.

[Number of organisms per cubic centimeter.]

	1896.			
	March.	March.	July.	November.
Day of examination,	10	25	9	13
Number of sample,	16312	16317	16945	17347
PLANTS.				
Diatomaceæ,	74	36	25	[illegible]
Asterionella,	68	36	4	11
Cyclotella,	0	0	9	9
Synedra,	3	1	6	4
Tabellaria,	3	0	6	0
Cyanophyceæ, Anabæna,	0	0	[illegible]	0
Algæ,	5	0	47	2
Protococcus,	5	0	22	2
Raphidium,	0	0	18	0
Staurogenia,	0	0	7	0
ANIMALS.				
Infusoria,	72	[illegible]	0	0
Dinobryon,	49	880	0	0
Mallomonas,	0	6	0	0
Peridinium,	5	2	0	0
Trachelomonas,	15	0	0	0
Uroglena,	3	2	0	0
Miscellaneous, Zoöglœa,	0	0	0	10
Total,	151	926	92	27

PEABODY.

Chemical Examination of Water from Spring Pond, Peabody.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16211	Mar. 9	Decided.	Slight.	.05	3.85	1.05	.0002	.0150	.0104	.0046	.71	.0000	.0000	.20	1.0
16309	Mar. 24	Decided.	V. slight.	.03	3.15	1.10	.0008	.0144	.0072	.0072	.64	.0050	.0000	.24	1.0
16944	July 8	Distinct.	Slight.	.03	3.55	0.60	.0008	.0150	.0126	.0024	.70	.0060	.0000	-	1.5
17848	Nov. 10	Slight.	Slight.	.03	3.90	1.45	.0012	.0110	.0094	.0016	.74	.0000	.0000	.15	1.4

Averages by Years.

-	1887*	-	-	.00	3.91	0.57	.0001	.0111	-	-	.63	.0000	-	-	-
-	1890†	-	-	.00	4.15	1.35	.0006	.0174	.0166	.0008	.67	.0150	.0000	-	1.8
-	1891	-	-	.01	3.69	0.99	.0006	.0123	.0097	.0027	.55	.0041	.0000	-	1.3
-	1894‡	-	-	.02	3.60	0.45	.0010	.0126	.0100	.0026	.64	.0020	.0000	.09	1.4
-	1895	-	-	.03	4.03	1.20	.0010	.0139	.0109	.0030	.73	.0013	.0000	.15	1.7
-	1896§	-	-	.03	3.65	1.11	.0008	.0136	.0108	.0033	.70	.0025	.0000	.18	1.2

* June, July and August. † December. ‡ September.

§ Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1896: Odor of the first two samples, fishy; of the third, faintly vegetable, becoming unpleasant on heating; of the last, faintly vegetable, disappearing on heating. —— The samples were collected from the pond.

Microscopical Examination of Water from Spring Pond, Peabody.

[Number of organisms per cubic centimeter.]

	1896. March.	1896. March.	1896. July.	1896. November.
Day of examination,	10	25	9	13
Number of sample,	16211	16309	16944	17848
PLANTS.				
Diatomaceæ,	325	15	98	106
Asterionella,	0	7	0	66
Cyclotella,	1	0	92	9
Synedra,	0	0	2	22
Tabellaria,	324	8	4	10
Algæ,	0	0	16	6
Protococcus,	0	0	14	0
Raphidium,	0	0	2	6

PEABODY.

Microscopical Examination of Water from Spring Pond, Peabody — Concluded.

[Number of organisms per cubic centimeter.]

	1896.			
	March.	March.	July.	November.
ANIMALS.				
Infusoria,	340	830	0	10
Dinobryon,	300	740	0	8
Trachelomonas,	0	0	0	2
Uroglena,	40	90	0	0
Miscellaneous,	.06	0	0	22
Acarina,	.06	0	0	0
Zoöglœa,	0	0	0	22
TOTAL,	666	846	114	146

Chemical Examination of Water from the Lower Basin, Peabody Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16213	Mar. 9	Slight.	V. slight.	.05	4.00	1.30	.0004	.0124	.0108	.0016	.68	.0280	.0001	.19	1.4
16318	Mar. 24	V. slight.	Slight.	.08	4.75	1.10	.0000	.0088	.0076	.0012	.66	.0280	.0001	.16	1.9
16946	July 8	Slight.	Slight.	.08	5.25	2.00	.0026	.0182	.0168	.0014	.80	.0120	.0001	-	1.8
17849	Nov. 10	V. slight.	Slight.	.04	4.65	1.20	.0010	.0082	.0070	.0012	.76	.0450	.0003	.11	1.7
Av.*				.05	4.62	1.47	.0013	.0123	.0110	.0013	.74	.0283	.0002	.14	1.7

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor of the first sample, distinctly fishy; of the second, none, becoming faintly vegetable on heating; of the last two, distinctly vegetable. —— The samples were collected from the basin, and represent a mixture of the water from Spring and Brown's ponds.

Microscopical Examination of Water from the Lower Basin, Peabody Water Works.

[Number of organisms per cubic centimeter.]

	1896.			
	March.	March.	July.	November.
Day of examination,	10	25	9	12
Number of sample,	16213	16318	16946	17849
PLANTS.				
Diatomaceæ,	51	39	3	116
Asterionella,	12	6	0	16
Cyclotella,	0	0	2	64
Navicula,	0	2	1	16
Synedra,	12	14	0	20
Tabellaria,	27	17	0	0

PEABODY.

Microscopical Examination of Water from the Lower Basin, Peabody Water Works — Concluded.

[Number of organisms per cubic centimeter.]

	1896.			
	March.	March.	July.	November.
PLANTS — Con.				
Algæ,	0	0	30	0
Pediastrum,	0	0	4	0
Protococcus,	0	0	26	0
ANIMALS.				
Infusoria,	98	115	0	16
Ciliated infusorian,	0	2	0	0
Dinobryon,	90	110	0	[illegible]
Euglena,	1	0	0	0
Mallomonas,	2	3	0	0
Peridinium,	1	0	0	0
Trachelomonas,	4	0	0	0
Vermes, Anurea,	0	0	2	0
Miscellaneous,	.04	0	.02	20
Acarina,	.04	0	.02	0
Zoöglea,	0	0	0	20
TOTAL,	140	154	35	152

PEMBROKE.

Chemical Examination of Water from Silver Lake in Pembroke.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
17014	July 16	Slight.	Slight.	.20	3.05	1.05	.0000	.0094	.0042	.0052	.62	.0000	.0001	.24	0.6
17015	July 16	Slight.	Slight.	.15	3.05	1.05	.0006	.0112	.0090	.0022	.60	.0000	.0000	.29	1.0
17133	Aug. 5	V. slight.	V. slight.	.07	3.85	1.25	.0008	.0120	.0098	.0022	.62	.0050	.0000	.25	0.7
17134	Aug. 5	V. slight	V. slight.	.08	3.75	1.20	.0004	.0094	.0078	.0016	.56	.0030	.0000	.27	0.6
17135	Aug. 5	V. slight.	V. slight.	.08	3.75	1.20	.0002	.0126	.0094	.0032	.56	.0030	.0000	.24	0.6
17136	Aug. 5	V. slight.	Slight.	.10	3.85	0.90	.0000	.0092	.0072	.0020	.58	.0030	.0000	.25	0.6

Odor of the first four samples, very faint or none, of the fifth, distinctly grassy or mouldy; of the last, faintly vegetable. — The first and second samples were collected from the central portion of the lake, at the surface and bottom, respectively; the third and fourth samples were collected from the northerly end of the lake, at the surface and bottom, respectively; the fifth and sixth samples were collected from the southerly end of the lake, at the surface and bottom, respectively. These analyses were made during an investigation with reference to an additional water supply for the city of Brockton.

PEMBROKE.

Microscopical Examination of Water from Silver Lake in Pembroke.

[Number of organisms per cubic centimeter.]

	1896.					
	July.	July.	Aug.	Aug.	Aug.	Aug.
Day of examination,	18	18	6	6	6	6
Number of sample,	17014	17015	17133	17134	17135	17136
PLANTS.						
Diatomaceæ,	298	6	60	133	24	124
Asterionella,	3	0	0	0	8	0
Cyclotella,	3	6	0	1	0	0
Melosira,	292	0	37	132	6	125
Synedra,	0	0	23	0	10	1
Cyanophyceæ,	0	7	83	2	27	2
Anabæna,	0	6	72	0	24	0
Clathrocystis,	0	0	11	0	0	0
Microcystis,	0	1	0	2	3	2
Algæ,	0	15	5	0	12	0
Protococcus,	0	15	2	0	9	0
Selenastrum,	0	0	0	0	3	0
Staurogenia,	0	0	3	0	0	0
ANIMALS.						
Infusoria, Tintinnidium,	1	0	0	0	0	0
Vermes,	0	2	1	0	0	0
Anuræa,	0	2	0	0	0	0
Polyarthra,	0	0	1	0	0	0
Crustacea, Daphnia,	0	0	.02	0	0	0
Miscellaneous,	5	5	10	10	.06	20
Acarina,	.02	.02	.06	.04	.06	0
Zoöglœa,	5	5	10	10	0	20
TOTAL,	304	35	159	145	63	146

PEMBROKE.

Chemical Examination of Water from Oldham Pond and Tubbs Meadow Brook in Pembroke.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites		
	1896.														
17013	July 16	Distinct.	Slight.	0.30	3.75	1.25	.0006	.0204	.0192	.0012	.65	.0000	.0001	.42	0.6
17132	Aug. 5	V. slight.	V. slight.	1.00	5.95	2.00	.0010	.0196	.0176	.0020	.62	.0030	.0000	.83	0.8

Odor of the first sample, none, becoming faintly grassy on heating; of the last, distinctly vegetable. —— The first sample was collected from the centre of Oldham Pond, near the surface; the second, from Tubbs Meadow Brook, at its entrance into Silver Lake.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows: No. 17013, 51; No. 17132, 28.

Water Supply of Pittsfield.

The advice of the State Board of Health to the city of Pittsfield with reference to taking an additional water supply from certain brooks in the vicinity of the city may be found on pages 33 to 35 of this volume. Analyses of samples of water collected from these brooks and other sources may be found on pages 277 to 279 of the annual report for 1895.

Chemical Examination of Water from Sacket Brook Reservoir, Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16125	Feb. 24	None.	None.	.07	6.80	1.00	.0000	.0050	.0042	.0008	.06	.0180	.0000	.11	4.9
16516	May 1	None.	V. slight	.12	5.55	1.05	.0008	.0084	.0066	.0018	.08	.0120	.0000	.18	4.1
16866	June 23	V. slight.	Slight.	.12	7.65	1.10	.0006	.0066	.0048	.0018	.10	.0080	.0000	.12	6.4
17305	Aug. 26	None.	V. slight.	.18	7.60	1.45	.0010	.0128	.0116	.0012	.07	.0090	.0000	.23	7.0
17441	Oct. 27	None.	Slight.	.12	6.80	1.20	.0000	.0050	.0044	.0006	.11	.0070	.0000	.21	5.4
18163	Dec. 21	None.	Slight.	.02	6.90	1.40	.0006	.0082	.0066	.0016	.12	.0220	.0000	.11	6.4
Av.				.10	6.80	1.20	.0005	.0077	.0064	.0013	.09	.0127	.0000	.16	5.7

Odor of the first sample, faintly earthy, disappearing on heating; of the others, none. A faintly fishy odor was developed in the August sample on heating. —— The samples were collected from the reservoir.

Microscopical Examination.

An insignificant number of organisms was found in each of these samples.

PITTSFIELD.

Chemical Examination of Water from Sacket Brook in the Vicinity of the Pumping Station of the Pittsfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
16132	Feb. 24	None.	V. slight.	.50	8.50	1.90	.0008	.0056	.0044	.0012	.07	.0270	.0001	.07	7.7
16515	May 1	None.	V. slight.	.05	7.45	1.30	.0000	.0074	.0058	.0016	.10	.0100	.0000	12	6.6
16864	June 23	V. slight.	Slight.	.10	9.60	1.90	.0016	.0106	.0096	.0010	.17	.0080	.0000	16	8.9
17329	Aug. 31	V. slight.	Slight.	.06	11.65	1.55	.0004	.0042	.0032	.0010	[illegible]	.0150	.0000	.07	10.0
17740	Oct. 27	None.	V slight.	.07	11.20	1.30	.0006	.0064	.0054	.0010	.11	.0070	.0000	.13	10.6
18162	Dec. 21	None.	V. slight.	.02	10.20	1.50	.0002	.0030	.0024	.0006	.09	.0200	.0000	.07	10.3
Av....	....	.. ..	....	.13	9.80	1.57	.0005	.0062	.0051	.0011	.10	.0145	[illegible]	10	9.0

Odor in June, distinctly unpleasant; in August, vegetable and mouldy; at other times, none.—The samples were collected from the brook.

Microscopical Examination.

An insignificant number of organisms was found in each of these samples.

Chemical Examination of Water from Ashley Brook Reservoir, Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
16123	Feb. 24	V. slight.	Slight.	.22	6.10	2.10	.0012	.0334	.0290	.0044	.08	.0220	.0000	.32	3.8
16518	May 1	None.	V. slight.	.20	5.60	1.35	.0004	.0092	.0066	.0026	.09	.0170	.0000	.27	3.6
16868	June 23	None	V slight.	.23	6.65	2.00	.0000	.0088	.0082	.0006	.08	.0070	.0001	.36	4.9
17304	Aug 26	Slight.	V. slight.	.20	7.05	1.60	.0010	.0180	.0130	.0050	.06	.0070	.0000	.35	5.4
17744	Oct 27	None.	None.	.15	7.10	1.70	.0004	.0080	.0074	.0006	.10	.0090	.0000	.30	6.8
18164	Dec. 27	None.	V. slight	.02	7.50	1.50	.0006	.0058	.0046	.0012	.12	.0160	.0000	.10	7.4
Av....	....	....	....	.17	6.67	1.71	.0006	.0139	.0115	.0024	.09	.0133	.0000	.28	5.3

Odor in February and June, faintly vegetable, in August, faintly grassy and mouldy; at other times, none.—Nos. 16518 and 16868 were collected from the brook, just above the reservoir; the others, from the reservoir. Water flows into this reservoir from Ashley Lake, situated about 2.5 miles further up the brook.

Microscopical Examination.

An insignificant number of organisms was found in each of these samples.

PITTSFIELD.

Chemical Examination of Water from Hathaway Brook Reservoir, Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16126	Feb. 24	None.	None.	.03	7.70	1.40	.0014	.0152	.0144	.0008	.10	.0300	.0001	.08	6.6
16517	May 1	None.	V. slight.	.04	7.00	1.15	.0008	.0098	.0060	.0038	.12	.0130	.0000	.10	6.3
16867	June 25	None.	V. slight.	.05	9.85	1.66	.0008	.0052	.0050	.0002	.10	.0130	.0000	.10	5.7
17303	Aug. 26	None.	V. slight.	.12	9.15	1.60	.0004	.0058	.0028	.0030	.04	.0090	.0000	.09	8.5
17742	Oct. 27	None.	V. slight.	.08	8.70	1.00	.0000	.0056	.0026	.0030	.08	.0070	.0000	.12	8.1
18166	Dec. 21	None.	V. slight.	.01	9.00	1.60	.0006	.0102	.0092	.0010	.14	.0250	[illegible]	.08	8.7
Av.	....	....	....	.05	8.57	1.37	.0006	.0086	.0067	.0019	.10	.0162	.0000	.09	7.5

Odor, none. —— The samples were collected from the reservoir.

Microscopical Examination.

An insignificant number of organisms was found in each of these samples.

Chemical Examination of Water from Mill Brook Reservoir, Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16124	Feb. 24	None.	V. slight.	.02	5.00	0.80	.0000	.0028	.0022	.0006	.07	.0200	.0000	.04	3.8
16514	May 1	None.	V. slight.	.05	4.25	0.80	.0008	.0062	.0046	.0016	.09	.0070	.0001	.12	3.3
16865	June 23	V. slight.	Slight.	.08	5.65	0.85	.0000	.0062	.0050	.0012	.11	.0070	.0000	.10	4.4
17330	Aug. 31	None.	V. slight.	.03	7.40	1.15	.0006	.0030	.0022	.0008	.08	.0100	.0000	.08	6.2
17746	Oct. 27	None.	Slight.	.02	4.90	0.70	.0008	.0046	.0030	.0016	.08	.0070	.0000	.08	3.6
18165	Dec. 21	None.	Slight.	.01	5.50	0.60	.0002	.0040	.0030	.0010	.12	.0250	.0000	.06	4.9
Av.	....	....	....	.03	5.45	0.82	.0004	.0044	.0033	.0011	.09	.0127	.0000	.08	4.4

Odor in June, faintly vegetable and mouldy; at other times, none. —— The samples were collected from the reservoir.

Microscopical Examination.

An insignificant number of organisms was found in each of these samples.

PLYMOUTH.

WATER SUPPLY OF PLYMOUTH.

The organism *Uroglena* appeared in the water of Little South Pond in the latter part of 1895, and was present until late in the spring of 1896, giving trouble during much of this time on account of the fishy taste which it imparted to the water. The advice of the State Board of Health to the water commissioners of the town of Plymouth relative to improving the quality of the water supply of the town may be found on pages 35 to 37 of this volume.

Chemical Examination of Water from Little South Pond, Plymouth.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15959	Jan. 22	Slight.	V. slight.	.01	2.55	1.00	.0000	.0172	.0118	[redacted]	.66	.0030	.0000	.20	0.1
16004	Feb. 3	V. slight.	Slight, green	.02	2.70	1.45	.0004	.0220	.0162	.0058	.69	.0030	.0000	.23	0.1
16065	Feb. 12	V. slight.	Slight.	.03	2.05	1.00	.0006	.0136	.0120	.0016	.65	.0030	.0000	.10	0.0
16219	Mar. 9	V. slight.	V. slight	.02	2.40	0.75	.0000	.0112	.0100	.0012	.61	.0000	.0000	.11	0.2
16380	Apr. 7	Distinct.	Slight, white.	.02	2.35	1.05	.0010	.0146	.0120	.0026	.64	.0000	.0000	.14	0.2
16624	May 19	Slight.	Slight.	.01	2.15	0.70	.0000	.0114	.0106	.0008	.63	.0050	.0000	.12	0.0
16719	June 3	Slight.	Slight.	.03	2.05	0.95	.0000	.0134	.0114	.0020	[redacted]	.0000	.0000	.18	0.0
16943	July 8	Slight.	Slight.	02	2.30	0.45	.0006	.0158	.0152	.0006	.62	.0060	.0000	-	0.0
17164	Aug. 11	V. slight.	V. slight.	.08	2.45	0.40	.0000	.0148	.0120	.0028	.70	.0000	.0000	.15	0.0
17371	Sept. 8	V. slight.	Slight.	.04	2.70	0.85	.0000	.0180	.0148	.0032	.67	.0000	.0000	.10	0.0
17661	Oct. 20	V. slight.	V. slight.	.03	2.40	0.70	.0046	.0182	.0164	.0018	.68	.0030	.0000	.12	0.0
17819	Nov. 10	V. slight.	V. slight.	.01	2.60	0.70	.0000	.0150	.0134	.0016	.68	.0000	.0000	.12	0.3
18002	Dec. 7	V. slight.	V. slight.	.01	[redacted]	0.60	.0002	.0108	[redacted]	[redacted]	.70	.0000	.0000	.05	0.0

Averages by Years.

-	1887*	-	-	.00	2.50	0.59	.0004	.0149	-	-	.64	.0004	-	-	-
-	1888†	-	-	.00	2.38	0.53	.0002	.0135	-	-	.60	.0023	.0000	-	-
-	1892‡	-	-	.00	2.52	1.05	.0009	.0121	.0096	.0025	.63	.0080	.0000	-	0.1
-	1893§	-	-	.02	2.30	0.67	.0007	.0128	.0107	.0021	.64	.0050	.0000	.09	0.5
-	1894	-	-	.06	2.60	0.63	.0010	.0138	.0114	.0024	.66	.0006	.0000	.12	0.2
-	1895	-	-	.02	2.36	0.78	.0002	.0155	.0124	.0031	.66	.0027	.0000	.12	0.3
-	1896‖	-	-	.02	2.38	0.78	.0006	.0148	.0126	.0022	.66	.0016	.0000	.13	0.1

* June to November. † February, April and May. ‡ March to June. § February and March.

‖ Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1896: Odor of the first three samples, decidedly fishy and oily; of the other samples, frequently vegetable and mouldy or grassy, rarely none. — The samples were collected from the pond.

PLYMOUTH.

Microscopical Examination of Water from Little South Pond, Plymouth.

[Number of organisms per cubic centimeter.]

	1896.												
	Jan.	Feb.	Feb.	Mar	Apr.	May.	June.	July.	Aug	Sept	Oct.	Nov.	Dec.
Day of examination,	24	4	13	11	9	21	4	8	12	6	22	11	8
Number of sample,	15939	16004	16055	16219	16380	16624	16719	16943	17164	17371	17581	17819	18002
PLANTS.													
Diatomaceæ,	0	0	15	4	2	22	10	4	0	3	0	20	52
Asterionella,	0	0	15	4	0	0	0	0	0	0	0	0	36
Cyclotella,	0	0	0	0	0	0	0	2	0	1	0	6	14
Synedra,	0	0	0	0	2	20	5	2	0	2	0	14	2
Tabellaria,	0	0	0	0	0	2	5	0	0	0	0	0	0
Cyanophyceæ,	0	0	[illegible]	0	0	0	10	16	9	32	16	0	0
Anabæna,	0	0	0	0	0	0	10	16	9	6	0	0	0
Merismopedia,	0	0	0	0	0	0	0	0	0	10	0	0	0
Microcystis,	0	0	0	0	0	0	0	0	0	16	16	0	0
Algæ,	[illegible]	0	0	0	0	0	0	43	9	0	0	0	2
Protococcus,	0	0	0	0	0	0	0	35	9	0	0	0	2
Raphidium,	0	0	0	0	0	0	0	8	0	0	0	0	0
ANIMALS.													
Infusoria,	20	10	29	67	8	0	2	0	0	0	0	0	0
Dinobryon,	0	0	25	52	8	0	2	0	0	0	0	0	0
Peridinium,	0	0	3	0	0	0	0	0	0	0	0	0	0
Uroglena,	20	10	1	15	pr.	0	pr.	0	0	0	0	0	0
Crustacea, Cyclops,	0	0	0	0	.02	0	0	0	0	0	0	0	.06
Miscellaneous,	0	0	0	.04	0	10	0	0	0	0	5	0	0
Acarina,	0	0	0	.04	0	0	0	0	0	0	0	0	0
Zoöglœa,	0	0	0	0	0	10	0	0	0	0	5	0	0
TOTAL,	20	10	44	71	10	38	22	62	16	35	21	20	54

PLYMOUTH.

Chemical Examination of Water from Great South, Boot and Lout Ponds, Plymouth.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16005	Feb. 3	V. slight.	None.	.02	2.55	1.40	.0006	.0204	.0174	.0030	75	.0080	.0000	.12	0.0
16382	Apr. 7	Slight.	V. slight.	.00	2.10	0.55	.0000	.0102	.0076	.0026	.63	.0030	.0000	.07	0.3
16006	Feb. 3	V. slight.	Slight.	.03	3.00	1.50	.0006	.0172	.0162	.0010	.72	.0000	.0000	14	0.1
16007	Feb. 3	V. slight	V. slight.	.30	3.05	1.76	.0056	.0244	.0223	.0016	.69	.0050	.0000	.49	0.0

Odor of the first two samples, none; of the last two, none, becoming faintly vegetable on heating. —— Nos. 16005 and 16382 were collected from Great South Pond, at its outlet into Little South Pond; No. 16006 was collected from Boot Pond, 100 feet from shore; No. 16007, from Lout Pond, near the pumping station.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

Chemical Examination of Water from Halfway Pond, Billington Sea and Gunner's Exchange Pond, Plymouth.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16008	Feb. 3	Distinct.	Slight, green.	.05	2.70	1.10	.0262	.0180	.0132	.0048	.60	.0050	.0000	.16	0.1
16009	Feb. 3	V. slight	V. slight.	.25	3.35	2.15	.0014	.0134	.0126	.0008	.57	.0070	.0000	.23	0.1
16381	Apr. 7	Slight.	V. slight	.02	2.15	0.90	.0000	.0160	.0148	.0012	.69	.0050	[illegible]	.11	0.2

Odor of the first sample, none, becoming faintly vegetable on heating; of the last two, faintly vegetable, becoming stronger on heating. —— The first sample was collected from Halfway Pond, at the bridge; the second from Billington Sea, at the ice house; and the last, from Gunner's Exchange Pond, at the northerly side, near the shore. These ponds are not used as sources of public water supply.

Microscopical Examination.

No. 16008. Diatomaceæ, *Asterionella*, 8; *Cyclotella*, 72; *Melosira*, 224; *Synedra*, 744. Algæ, *Dictyosphærium*, 44; *Staurastrum*, 7. Infusoria, *Dinobryon*, 12; *Peridinium*, 3. Crustacea, *Bosmina*, .02; *Cyclops*, .06; *Daphnia*, .06. Miscellaneous, *Acarina*, .04; *Zoöglœa*, 120. Total, 1,234.

No. 16009. Infusoria, *Dinobryon*, 8. Vermes, *Anuræa*, 1. Total, 9.

No. 16381. Infusoria, *Dinobryon*, 32. Crustacea, *Cyclops*, .04. Total, 32.

Water Supply of Provincetown.

Chemical Examination of Water from the Tubular Wells of the Provincetown Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
15857	Jan. 8	Decided, floc.	Cons.	1.40	8.90	.0096	.0096	2.26	.0070	.0000	.85	2.1	.4400
15869	Jan. 13	Distinct, milky.	Slight, rusty.	1.40	8.00	.0058	.0110	2.25	.0070	.0000	.79	1.6	.3000
16197	Mar. 5	Decided, rusty.	Cons., floc.	1.30	8.20	.0092	.0146	2.16	.0070	.0000	.70	1.6	.6900
16384	Apr. 9	Decided, rusty.	Cons., rusty.	1.10	9.40	.0070	.0130	2.39	.0020	.0002	.78	2.5	.4450
16427	Apr. 16	Decided, milky.	Cons., rusty.	1.20	9.20	.0074	.0114	2.24	.0070	.0001	.75	1.7	.5000
16428	Apr. 16	Decided, milky	Cons., rusty.	1.20	8.90	.0092	.0100	2.21	.0060	.0001	.78	1.7	.4900
16551	May 6	Decided, milky.	Slight.	1.30	8.90	.0068	.0118	2.30	.0070	.0000	.74	1.8	.4200
16956	July 9	Decided, milky.	Cons., rusty.	2.00	9.90	.0082	.0112	2.40	.0080	.0000	.84	2.7	.5250
17369	Sept. 7	Decided, rusty.	Heavy, rusty.	1.10	10.50	.0086	.0174	2.34	.0080	.0000	.70	2.0	.5600
17753	Oct. 30	Decided, milky.	Cons., rusty.	1.10	8.70	.0090	.0106	2.22	.0050	.0001	.70	2.1	.5850

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1893	-	-	0.99	7.65	.0027	.0082	2.06	.0023	.0001	.74	1.4	.1340
-	1894	-	-	1.09	7.91	.0043	.0090	2.19	.0039	.0000	.80	1.7	.2212
-	1895	-	-	1.21	8.56	.0074	.0106	2.15	.0045	.0000	.77	2.2	.3764
-	1896*	-	-	1.34	9.12	.0080	.0125	2.28	.0058	.0000	.75	2.0	.5162

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Note to analyses of 1896: Odor, vegetable.——The samples were collected from a faucet at the pumping station.

Microscopical Examination of Water from the Tubular Wells of the Provincetown Water Works.

[Number of organisms per cubic centimeter.]

	1896. Jan.	Jan.	Mar.	Apr.	Apr.	Apr	May.	July.	Sept.	Oct.
Day of examination,	11	15	7	10	17	17	7	9	8	31
Number of sample,	15857	15869	16197	16384	16427	16428	16551	16956	17369	17753
PLANTS.										
Fungi, Crenothrix,	4,000	1,000	520	4,800	8,000	1,800	2,400	2,000	1,800	656

PROVINCETOWN.

Chemical Examination of Water from the Standpipe of the Provincetown Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16435	Apr. 17	Decided.	Cons., rusty.	1.00	[illegible]	.0004	.0152	2.21	.0150	.0001	.72	1.6	.4100
16436	Apr. 17	Distinct.	Cons., rusty.	0.95	8.10	.0020	.0140	2.23	0050	.0001	.60	1.7	.3300

Odor of the first sample, faintly tarry; of the last, faintly sweetish. —— The first sample was collected from the standpipe, before pumping; and the last, from the standpipe, after pumping.

Microscopical Examination.

No. 16435. Fungi, *Crenothrix*, 5,000.
No. 16436. Fungi, *Crenothrix*, 4,000.

Chemical Examination of Water from Faucets in Provincetown, supplied from the Provincetown Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15870	Jan. 13	Decided, milky.	Slight, rusty.	1.00	8.10	.0010	.0170	2.30	.0100	.0000	.71	1.5	.3400
16429	Apr. 16	Decided, milky.	Slight, white.	0.95	8.30	.0014	.0110	2.24	.0050	.0001	.51	1.6	.2700
16430	Apr. 16	Decided, milky.	Slight, white.	1.00	8.30	.0010	.0102	2.24	.0070	.0001	.52	1.6	.2700

Odor, vegetable or mouldy. —— The samples were collected from faucets in the town.

Microscopical Examination.

No. 15870. Fungi, *Crenothrix*, 192.
No. 16429. Fungi, *Crenothrix*, 800.
No. 16430. Fungi, *Crenothrix*, 800.

Water Supply of Quincy.

Chemical Examination of Water from Town Brook just above the Storage Reservoir of the Quincy Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15969	Jan. 27	Slight.	Slight.	0.47	3.95	1.45	.0006	.0116	.0100	.0016	.51	.0070	.0000	0.52	0.3
16132	Feb. 24	Slight.	Slight.	0.40	3.60	1.00	.0002	.0114	.0100	.0014	.53	.0060	.0001	0.44	0.3
16300	Mar. 23	Slight.	Slight.	0.23	2.90	1.00	.0004	.0100	.0076	.0024	.46	.0070	.0000	0.38	0.5
16482	Apr. 27	Slight.	Slight.	1.15	3.90	1.50	.0006	.0214	.0198	.0016	.44	.0080	.0000	0.67	0.9
16661	May 25	Slight.	Slight.	1.10	4.40	1.85	.0002	.0202	.0186	.0016	.52	.0090	.0001	0.71	0.6
16849	June 23	V. slight.	Cons.	1.15	4.60	1.95	.0004	.0262	.0242	.0020	.52	.0060	.0000	1.07	0.9
17054	July 27	Slight.	Cons.	0.60	5.00	1.60	.0000	.0182	.0172	.0010	.66	.0100	.0000	0.74	0.7
17268	Aug. 24	Slight.	Slight.	0.50	4.25	1.10	.0006	.0114	.0104	.0010	.57	.0060	.0001	0.36	0.6
17517	Sept. 21	Slight.	Slight.	1.90	5.70	3.25	.0000	.0474	.0456	.0018	.65	.0020	.0001	1.60	1.4
17714	Oct. 26	None.	V. slight.	0.95	4.75	2.05	.0010	.0174	.0160	.0014	.71	.0000	.0000	1.01	0.6
17997	Nov. 23	V. slight.	Slight.	0.85	4.40	1.45	.0008	.0146	.0130	.0016	.66	.0060	.0001	0.64	0.6
18216	Dec. 30	V. slight.	Slight.	0.33	3.30	1.45	.0008	.0128	.0108	.0020	.65	.0100	.0000	0.42	0.6

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Albuminoid Dissolved.	Albuminoid Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1887*	-	-	0.50	5.30	1.50	.0000	.0138	-	-	.65	.0080	-	-	-
-	1888†	-	-	0.45	3.64	1.05	[illegible]	.0122	-	-	.54	.0070	.0008	-	-
-	1889	-	-	1.21	4.61	1.87	.0018	.0239	.0203	.0036	.48	.0073	.0001	-	-
-	1890	-	-	0.73	5.22	2.17	.0024	.0187	.0155	.0032	.52	.0125	.0002	-	1.3
-	1891	-	-	0.72	4.22	1.50	[illegible]	.0156	.0132	.0024	.49	.0112	.0001	-	0.7
-	1892	-	-	0.87	4.57	1.56	.0041	.0191	.0159	.0032	.55	.0114	.0001	-	0.8
-	1893	-	-	0.98	4.53	1.81	.0014	.0166	.0140	.0026	.57	.0110	.0001	0.79	0.8
-	1894	-	-	0.92	4.31	[illegible]	[illegible]	.0158	.0134	.0024	.63	.0030	.0000	0.64	0.6
-	1895	-	-	0.84	4.31	1.73	.0002	.0177	.0152	.0025	.59	.0061	.0001	[illegible]	0.6
-	1896	-	-	0.81	4.27	1.64	[illegible]	.0185	.0169	.0016	.57	[illegible]	[illegible]	0.73	0.7

* October. † November and December.

Note to analyses of 1896: Odor, vegetable, frequently mouldy. —— The samples were collected from the brook, above the reservoir.

Microscopical Examination.

An insignificant number of organisms was found in each of these samples.

QUINCY.

Chemical Examination of Water from the Storage Reservoir of the Quincy Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1896.														
16958	Jan. 27	Slight.	Slight.	.42	3.95	1.55	.0024	.0160	.0134	.0026	.52	.0100	.0000	.37	[redacted]
16133	Feb. 24	Distinct.	Slight.	.40	3.25	0.95	.0006	.0168	.0142	.0026	.60	.0120	.0001	.47	0.5
16301	Mar. 23	Slight.	Slight.	.30	3.55	1.15	.0030	.0124	.0100	[redacted]	.53	.0120	[redacted]	.35	0.6
16485	Apr. 27	Distinct.	Slight.	.37	3.20	1.10	.0006	.0192	.0148	.0044	.50	.0090	.0002	.37	0.5
16662	May 25	Decided.	Cons.	.40	3.20	1.50	.0002	.0272	.0170	.0102	.60	.0080	.[redacted]	[redacted]	0.6
16860	June 22	Slight.	Slight.	.47	[redacted]	1.30	.0000	.0200	.0174	.0026	.60	.0020	.0000	.44	0.9
17066	July 27	Decided.	Slight.	.63	4.10	1.60	.0006	[redacted]	.0222	.0102	.64	.0030	.0000	.46	0.6
17289	Aug. 24	Decided.	Cons.	.65	3.90	1.60	.0004	.0292	.0204	.0088	.62	.0000	.0001	.52	0.5
17516	Sept. 21	Distinct.	Cons.	.90	4.35	1.95	.0006	.0338	.0228	.0110	.66	.0000	.0001	.64	0.6
17715	Oct. 26	Distinct.	Cons.	.75	4.70	1.70	.0062	.0278	.0202	.0076	.75	.0020	.0001	.63	0.7
17938	Nov. 23	Distinct.	Slight.	.65	4.70	1.75	.0004	.0316	.0162	.0154	.74	.0070	.0001	.60	0.7
18217	Dec. 30	Slight.	Slight.	.62	4.15	1.65	.0096	.0204	.0142	.0062	.78	.0090	.0000	.56	0.6

Averages by Years.

-	1888*	-	-	.50	3.95	1.13	[redacted]	.0178	.0132	.0046	.66	.0150	.0003	-	-
-	1889	-	-	.91	3.76	1.19	.0116	.0303	.0238	.0065	.53	.0087	.0003	-	-
-	1890	-	-	.70	4.66	1.76	[redacted]	.0249	.0178	.0071	.54	.0166	.0002	-	1.4
-	1891	-	-	.70	3.97	1.60	.0027	.0274	.0178	.0096	.50	.0100	.0000	-	0.7
-	1892	-	-	.66	4.07	1.41	.0051	.0237	.0175	.0062	.61	.0096	.0001	-	0.9
-	1893	-	-	.56	3.81	1.51	.0052	.0218	.0172	.0046	.61	.0104	.0001	.51	0.8
-	1894	-	-	.67	4.26	1.71	[redacted]	.0229	.0167	.0062	.67	.0058	.0000	.60	0.8
-	1895	-	-	.65	4.22	1.77	.0009	.0301	.0187	.0114	.65	.0040	.0000	.56	0.7
-	1896	-	-	.57	3.86	1.47	.0021	.0235	.0165	.0070	.63	.0062	.0001	.49	0.7

* November and December.

NOTE to analyses of 1896: Odor, distinctly vegetable; in May, June, July and September, also disagreeable. —— The samples were collected from the reservoir.

For heights of water in this reservoir see table on page 294.

QUINCY.

Microscopical Examination of Water from the Storage Reservoir of the Quincy Water Works.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	28	25	24	29	26	28	28	25	22	27	25	31
Number of sample,	15958	16133	16301	16483	16662	16850	17066	17269	17518	17716	17988	18217
PLANTS.												
Diatomaceæ,	[illegible]	2	15	30	25	5	[illegible]	940	170	381	140	2
Asterionella,	0	0	1	0	0	0	14	940	0	4	32	0
Fragilaria,	0	0	0	5	8	0	0	0	0	2	0	0
Melosira,	0	0	4	0	0	0	8	0	0	0	0	0
Meridion,	0	0	1	0	0	0	0	0	0	10	0	1
Navicula,	0	1	0	0	0	0	0	0	0	2	4	0
Synedra,	2	1	9	17	7	5	44	0	80	360	72	1
Tabellaria,	0	0	0	8	10	0	2	0	90	3	32	0
Algæ,	2	8	41	10	2	0	1	6	2	37	64	1
Conferva,	2	0	0	[illegible]	0	0	0	0	0	0	0	0
Protococcus,	0	0	0	0	0	0	1	5	0	15	0	1
Raphidium,	0	0	0	0	2	0	0	0	0	8	4	0
Scenedesmus,	0	0	1	0	0	0	0	1	2	14	60	0
Zoöspores,	0	8	40	2	0	0	0	0	0	0	0	0
Fungi, Leptothrix,	0	0	0	0	0	0	0	0	20	0	0	0
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	0	1	0	0	0	0	1	0	0
Infusoria,	4	26	7	52	238	244	505	117	126	25	72	40
Codonella,	0	0	0	0	0	0	0	0	2	5	0	1
Dinobryon,	0	13	0	31	9	0	304	12	0	17	0	0
Mallomonas,	0	0	0	0	0	0	0	1	0	0	4	0
Monas,	0	0	0	1	0	0	0	0	0	0	4	0
Peridinium,	4	13	7	20	228	244	200	56	124	1	0	32
Raphidomonas,	0	0	0	0	0	0	0	44	0	0	0	0
Tintinnidium,	0	0	0	0	1	0	0	0	0	1	4	0
Trachelomonas,	0	0	0	0	0	0	1	4	0	1	0	[illegible]
Vermes,	0	2	2	0	1	0	6	1	1	0	0	4
Anuræa,	0	0	2	0	0	0	2	0	0	0	0	4
Asplanchna,	0	2	0	0	0	0	0	0	0	0	0	0
Rotatorian ova,	0	0	0	0	0	0	1	0	1	0	0	0
Rotifer,	0	0	0	0	1	0	3	1	0	0	0	0
Crustacea,	0	0	0	0	0	0	0	.04	0	0	.04	0
Bosmina,	0	0	0	0	0	0	0	.02	0	0	0	0
Cyclops,	0	0	0	0	0	0	0	.02	0	0	.04	0
Miscellaneous,	0	0	[illegible]	[illegible]	100	5	40	20	0	10	20	5
Acarina,	0	0	0	.02	.02	0	0	0	0	0	0	0
Zoöglœa,	0	0	5	50	100	5	40	20	0	10	20	5
TOTAL,	8	36	68	152	367	254	614	1,084	319	464	236	52

QUINCY.

Table showing Heights of Water in the Storage Reservoir of the Quincy Water Works on the First of Each Month in 1896.

[High-water mark is 86.71 feet above city base.]

1896.	Heights above City Base.	1896.	Heights above City Base.
	Feet.		Feet.
Jan. 1,	86.71	July 1,	84.46
Feb. 1,	86.71	Aug. 1,	82.23
March 1,	86.71	Sept. 1,	79.58
April 1,	[illegible]	Oct. 1,	81.48
May 1,	86.71	Nov. 1,	83.78
June 1,	85.60	Dec. 1,	86.11

Water Supply of Randolph and Holbrook.

Chemical Examination of Water from Great Pond in Randolph and Braintree.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16041	Feb. 11	Slight, clayey.	Slight.	.70	3.90	1.50	.0018	.0250	.0224	.0026	.40	.0150	.0003	.66	0.6
16363	Apr. 8	Slight.	Slight.	.42	3.20	1.35	[illegible]	.0150	.0114	.0036	.46	.0070	.0001	.46	0.5
16728	June 3	Decided.	Slight.	.65	3.30	1.65	.0028	.0264	.0250	.0014	.53	.0080	.0001	.54	0.7
17186	Aug. 11	Distinct.	Slight.	.36	4.05	2.30	.0024	.0252	.0214	.0038	.60	.0000	.0000	.51	0.6
17634	Oct. 13	Slight.	Slight.	.50	4.30	1.65	.0002	.0206	.0196	[illegible]	.59	.0050	.0001	.63	0.9
18015	Dec. 8	Slight.	Slight.	.66	4.65	1.75	.0002	.0204	.0170	.0034	.68	.0030	.0001	.67	1.2

Averages by Years.

-	1892*	-	-	.50	4.06	1.75	.0018	.0198	.0156	.0042	.57	.0150	.0000	-	0.9
-	1893	-	-	.48	4.73	1.84	.0017	.0226	.0176	.0050	.58	.0050	.0000	.51	1.1
-	1894	-	-	.47	4.16	1.68	.0004	.0156	.0137	.0019	.63	.0020	.0000	.45	1.2
-	1895†	-	-	.53	3.75	1.99	.0004	.0190	.0172	.0018	.58	.0050	.0000	.58	1.4
-	1896	-	-	.53	3.92	1.70	.0013	.0221	.0195	.0026	.54	.0055	.0001	.58	0.9

* March. † July.

NOTE to analyses of 1896: Odor, generally distinctly vegetable, sometimes mouldy. —— Nos. 17634 and 18015 were collected from a faucet in Holbrook; the remaining samples from the pond.

RANDOLPH AND HOLBROOK.

Microscopical Examination of Water from Great Pond in Randolph and Braintree

[Number of organisms per cubic centimeter.]

	1896.					
	Feb.	Apr.	June.	Aug.	Oct.	Dec.
Day of examination,	12	10	4	13	14	9
Number of sample,	16041	16383	16723	17188	17634	18015
PLANTS.						
Diatomaceæ,	1	27	10	4	2	4
Stephanodiscus,	0	2	10	0	2	4
Synedra,	1	5	0	4	0	0
Tabellaria,	0	20	0	0	0	0
Cyanophyceæ,	0	0	3	33	10	0
Anabæna,	0	0	3	9	0	0
Merismopedia,	0	0	0	24	0	0
Microcystis,	0	0	0	0	10	0
Algæ,	0	1	0	20	2	0
Protococcus,	0	0	0	4	2	0
Raphidium,	0	1	0	16	0	0
ANIMALS.						
Infusoria,	100	6	2	0	0	0
Codonella,	0	0	1	0	0	0
Dinobryon,	100	5	0	0	0	0
Mallomonas,	0	0	1	0	0	0
Peridinium,	0	1	0	0	0	0
Miscellaneous, Zoöglœa,	0	0	0	40	0	0
TOTAL,	101	34	15	97	14	4

WATER SUPPLY OF READING.

In July, 1896, a mechanical filter was put in operation, through which all the water supplied to the town is passed. Water from the filter-gallery is first pumped to a tank, on entering which it is treated with milk of lime. As the water passes through the tank, it is aerated by means of perforated nozzles in the bottom of the tank, supplied with compressed air. From this aerating tank it passes to the settling tank, receiving in its passage from one tank to the other a solution of aluminum sulphate. In the settling tank a large portion of the iron is precipitated, and the supernatant liquid passes to the filters, which consist of 6 circular tanks, 8 feet 8 inches in diameter and 8 feet deep, partially filled with sand. From the filters water passes to a small storage tank, from which it is pumped to the stand-pipe and supplied to the town. The filters are washed out each day, by reversing the current of water, at the same time agi-

READING.

tating the sand. It will be seen from the tables of analyses which follow that a large proportion of the iron is removed, but that the hardness of the water is greatly increased: —

Chemical Examination of Water from the Filter-gallery of the Reading Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15854	Jan. 5	Decided, milky.	Cons., rusty.	0.40	13.20	.0066	.0092	.48	.0060	.0001	.36	4.7	.3800
16014	Feb. 3	Decided, milky.	Cons., rusty.	0.35	13.70	.0062	.0064	.44	.0150	.0000	.32	-	.3360
16200	Mar. 6	Distinct, milky.	Slight, rusty.	0.27	11.00	.0032	[illegible]	.48	.0050	.0003	.11	4.6	.0900
16376	Apr. 8	V. slight.	Slight, rusty.	0.55	10.10	.0056	.0086	.44	.0060	.0001	.34	4.3	.1900
16552	May 6	Distinct, milky.	Slight, rusty.	0.90	7.80	.0080	.0130	.50	.0050	.0000	.60	2.5	.1250
16731	June 3	Distinct.	Cons., brown.	0.80	9.60	.0066	.0130	.45	.0030	.0000	.71	3.8	.2500
17076	July 27	Decided, floc.	Cons., rusty.	0.40	9.50	.0048	.0076	.58	.0050	.0000	.34	3.6	.0550
17152	Aug. 10	Decided.	Cons.	0.65	5.70	.0046	.0056	.54	.0000	.0001	.36	2.6	.1400
17287	Aug. 25	Decided.	Cons.	0.60	7.40	.0070	.0064	.56	.0000	.0000	.35	2.5	.0950
17392	Sept. 5	Distinct, rusty.	Cons., brown.	0.50	6.60	.0056	.0046	.62	[illegible]	.0000	.17	2.6	.0960
17526	Sept. 21	Decided, rusty.	Heavy, rusty.	0.38	12.20	.0064	.0068	.56	[illegible]	.0000	.32	3.9	.3350
17592	Oct. 6	Decided, floc.	Cons., rusty.	1.10	13.20	.0090	.0120	.50	.0030	.0001	.41	4.0	.3800
17709	Oct. 21	Decided, rusty.	Heavy, rusty.	0.10	14.90	.0104	.0106	.53	.0050	.0000	.49	5.2	.5600
17833	Nov. 10	Decided.	Cons.	0.60	16.40	.0110	.0098	.56	.0060	.0000	.48	5.8	.5250
17966	Nov. 24	Decided, milky.	Heavy, rusty.	0.50	15.10	.0102	.0090	.57	.0080	.0001	.45	6.0	.4800
18019	Dec. 8	Decided, floc.	Heavy, yellow.	0.40	16.70	.0092	.0120	.48	.0070	.0001	.57	6.3	.4450
18167	Dec. 20	Decided, milky.	Cons., rusty.	0.50	15.00	.0104	.0092	.55	.0080	[illegible]	.49	6.0	.4850

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1891		-	0.13	12.96	.0016	.0063	.63	.0094	.0001	-	5.1	-
-	1892	-	-	0.44	9.25	.0042	.0073	.54	.0071	.0001	-	3.4	-
-	1893	-	-	0.64	10.08	.0034	.0067	.56	.0032	[illegible]	.35	3.9	.1251
-	1894	-	-	0.45	12.76	.0043	.0107	.68	.0029	.0000	.35	5.0	.2642
-	1895	-	-	0.61	13.86	.0068	.0114	.72	.0048	.0000	.44	5.8	.2277
-	1896*	-	-	0.52	11.50	.0060	.0089	.51	.0059	.0001	.40	4.1	.2696

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1896: Odor, generally vegetable or mouldy, frequently none. —— The samples were collected from a faucet at the pumping station.

READING.

Microscopical Examination of Water from the Filter-gallery of the Reading Water Works.

[Number of organisms per cubic centimeter.]

	1896.								
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Aug.
Day of examination,	9	5	10	9	7	6	30	11	26
Number of sample,	15884	16014	16300	16378	16552	16731	17075	17152	17257
PLANTS.									
Fungi, Crenothrix,	5,280	2,080	12,000	1,200	3,280	17,600	12,160	4,800	14,800

Microscopical Examination of Water from the Filter-gallery of the Reading Water Works — Concluded.

[Number of organisms per cubic centimeter.]

	1896.							
	Sept.	Sept.	Oct.	Oct.	Nov.	Nov.	Dec.	Dec.
Day of examination,	10	22	6	24	12	27	9	22
Number of sample,	17302	17526	17597	17709	17833	17956	18019	18167
PLANTS.								
Fungi, Crenothrix,	2,560	28,000	16,000	22,800	16,800	14,800	4,680	3,800

Chemical Examination of Water from Reading Filter-gallery after passing through the Mechanical Filter.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16964	July 8	None.	None.	.30	17.40	.0070	.0068	.54	.0070	.0000	.41	10.0	.0060
17076	July 27	None.	None.	.13	16.00	.0058	.0056	.52	.0030	.0000	.15	8.2	.0090
17153	Aug. 10	V. slight.	None.	.30	14.50	.0040	.0046	.56	.0000	.0002	.24	7.9	.0210
17258	Aug. 25	None.	V. slight.	.20	14.20	.0044	.0056	.52	.0020	.0010	.20	8.0	.0030
17303	Sept. 8	None.	V. slight.	.20	13.90	.0030	.0044	.61	.0030	.0015	.17	7.3	.0100
17527	Sept. 21	None.	None.	.10	18.00	.0048	.0062	.56	.0040	.0025	.23	10.0	.0000
17598	Oct. 6	V. slight.	None.	.09	20.40	.0010	.0066	.57	.0030	.0035	.29	11.3	.0100
17710	Oct. 21	None.	None.	.08	24.80	.0026	.0078	.57	.0050	.0060	.34	15.5	.0000
17834	Nov. 10	None.	None.	.10	26.80	.0032	.0082	.54	.0050	.0015	.25	14.7	.0360
17957	Nov. 24	None.	None.	.12	24.60	.0022	.0082	.61	.0050	.0010	.25	15.0	.0010
18020	Dec. 8	None.	None.	.10	20.60	.0016	.0078	.56	.0050	.0010	.23	14.5	.0020
18168	Dec. 30	None.	None.	.10	22.80	.0022	.0068	.57	.0100	.0010	.24	13.5	.0060
Av.*				.15	19.42	.0035	.0067	.56	.0043	.0016	.24	11.3	.0091

* Where more than one sample was collected in a month the mean analysis for that month has been used in making the average.

Odor, none. On heating, a slight odor was developed in some of the samples.—— The samples were collected from the weir over which the filtered water passes on its entrance to the storage tank at the pumping station.

Microscopical Examination.

An insignificant number of organisms was found in some of these samples.

REVERE AND WINTHROP.

WATER SUPPLY OF REVERE AND WINTHROP — REVERE WATER COMPANY.

The advice of the State Board of Health to the Revere Water Company, relative to securing an additional water supply, may be found on pages 37 to 39 of this volume.

The wells of this company, located at Revere, receive a large amount of sea-water, which increases with the increased draft on the wells during the summer and fall, making the water exceptionally hard and giving it a saline taste.

Chemical Examination of Water from the Wells of the Revere Water Company at Revere.

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			Residue on Evaporation.	AMMONIA.		Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15865	Jan. 8	None.	None.	.00	70.00	.0004	.0000	32.06	.0050	.0009	.06	26.4	.0010
16023	Feb. 4	None.	None.	.00	88.60	.0000	.0000	32.60	.0750	.0018	.10	40.0	.0020
16251	Mar. 13	None.	None.	.00	86.80	.0000	.0008	31.38	.0680	.0015	.05	36.5	[illegible]
16426	Apr. 16	None.	None.	.00	76.40	.0000	.0010	24.20	.0950	.0050	.03	28.5	.0010
16605	May 13	None.	None.	.00	78.00	.0000	.0014	27.12	.1500	.0020	.05	32.0	.0010
16727	June 3	None.	None.	.00	106.60	.0002	.0028	31.72	.1500	.0017	.07	40.0	.0000
16952	July 7	None.	None.	.00	130.80	.0000	.0022	46.60	.0150	.0018	–	54.5	.0030
17148	Aug. 5	V. slight, milky.	None.	.01	161.00	.0000	.0014	56.10	.0170	.0008	.11	47.5	.0020
17288	Sept. 8	V. slight, milky.	Slight, white.	.02	167.70	.0004	.0004	63.72	.0100	.0018	.08	56.5	.0010
17618	Oct. 8	None.	Slight.	.02	173.80	.0012	.0024	69.10	.0650	.0016	.12	77.5	.0140
17790	Nov. 5	None.	V. slight.	.01	161.80	.0004	.0000	64.50	.0650	.0015	.09	71.0	.0080
17990	Dec. 2	None.	Slight.	.00	154.90	.0000	.0010	61.44	.0650	.0004	.08	47.0	.0060

Averages by Years.

–	1887*	–	–	.00	23.17	.0002	.0016	3.37	.1670	–	–	–	–
–	1888	–	–	.00	22.69	.0001	.0022	3.49	.1288	.0022	–	–	–
–	1889†	–	–	.00	22.72	.0000	.0016	3.28	.1830	.0027	–	–	–
–	1890‡	–	–	.00	–	.0006	.0012	3.39	.1750	.0024	–	–	–
–	1893	–	–	[illegible]	60.29	.0002	.0019	13.05	.0907	.0019	.04	23.0	.0086
–	1894	–	–	.03	91.99	.0004	.0011	20.80	.0963	.0013	.06	41.0	.0219
–	1895	–	–	.02	104.73	.0002	.0012	36.84	.0652	.0014	.07	45.6	.0120
–	1896	–	–	.00	121.30	.0002	.0011	45.21	.0733	.0017	.08	46.4	.0032

* June to December. † January to May. ‡ March.

NOTE to analyses of 1896: Odor, none. —— The samples were collected from a faucet at the pumping station.

Microscopical Examination.

An insignificant number of organisms was found in No. 16426; no organisms were found in the other samples.

REVERE AND WINTHROP.

Chemical Examination of Water from Tubular Wells of the Revere Water Company at Cliftondale, Saugus.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
15664	Jan. 5	None.	V. slight.	.00	13.30	.0002	.0012	1.26	.1360	.0002	.01	6.3	.0010
16022	Feb. 4	None.	None.	.03	15.00	.0002	.0004	1.22	.1900	.0020	.00	7.9	.0080
16293	Mar. 9	None.	None.	.00	14.20	.0002	.0010	1.32	.1100	.0006	.02	6.0	.0000
[redacted]	Apr. 14	None.	None.	.00	13.90	.0000	.0018	1.26	.1500	.0000	.02	6.4	.0010
16606	May 13	None.	None.	[redacted]	13.90	.0004	.0008	1.27	.1600	.0000	.08	6.8	.0000
16726	June 3	None.	None.	.00	13.50	.0000	.0016	1.30	.1900	[redacted]	.05	6.7	.0020
16953	July 7	None.	None.	.00	14.70	.0000	.0014	1.27	.0600	.0000	-	6.6	.0020
17149	Aug. 5	None.	None.	.00	13.50	.0000	.0000	1.27	.1500	.0000	.03	-	.0000
17389	Sept. 8	None.	None.	.02	15.60	.0000	.0004	[redacted]	.0780	.0000	.00	7.1	.0000
17617	Oct. 8	None.	None.	.00	13.40	.0002	.0022	1.22	.0650	.0000	.03	7.1	.0020
17791	Nov. 4	None.	None.	.02	13.80	[redacted]	.0012	1.22	.1200	.0000	.03	6.6	.0080
17991	Dec. 2	None.	None.	.00	14.20	.0000	.0020	1.34	.1250	.0000	.05	8.3	.0050

Averages by Years.

-	1891*	-	-	[redacted]	11.60	.0018	.0014	0.86	.0100	.0000	-	5.3	-
-	1892	-	-	.01	11.65	.0000	.0008	1.16	.0123	.0035	-	6.0	.0116
-	1893	-	-	.00	12.60	.0002	.0010	1.32	.0872	.0079	.08	6.4	.0067
-	1894	-	-	.01	[redacted]	[redacted]	[redacted]	1.24	.0706	.0012	.03	6.5	.0058
-	1895	-	-	.01	13.62	.0003	.0016	1.18	.1053	.0033	.08	6.9	.0011
-	1896	-	-	.01	14.08	.0002	.0012	1.26	[redacted]	.0002	.02	6.9	.0024

* September.

Note to analyses of 1896: Odor, none. On heating, a faintly earthy odor was developed in the October and December samples. —— The samples were collected from faucets in Revere and Saugus, supplied wholly from the Saugus wells.

Microscopical Examination.

An insignificant number of organisms was found in sample No. 16022; no organisms were found in the other samples.

REVERE AND WINTHROP.

Chemical Examination of Water from Tubular Test Wells in Revere.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates	Nitrites.			
	1896.												
16297	Mar. 19	Decided, clayey.	Cons., earthy.	.02	6.60	.0000	.0026	0.61	.0660	.0000	.04	2.1	[illegible]
16725	June 1	Distinct, clayey.	Cons., sandy.	.12	9.00	.0000	.0006	0.42	.0030	.0000	.06	3.5	.1400
16642	June 19	Distinct, clayey.	Cons., rusty.	.10	7.30	.0000	.0002	0.44	.0030	.0000	.00	3.1	.0280
17364	Sept. 2	None	Slight.	.00	16.40	.0000	.0026	2.03	.2750	.0000	.02	6.1	.0010
17365	Sept. 2	Decided, clayey.	Heavy, clayey.	.02	22.40	.1400	.0060	0.59	.0000	.0000	.14	9.7	.0600
17542	Sept. 21	Decided, clayey.	Heavy.	.02	16.40	.1360	.0054	0.58	.0000	.0000	.19	9.1	.0000
17543	Sept. 21	Decided, clayey.	Heavy.	.03	17.00	.1328	.0048	1.36	.0050	0000	.14	10.3	.0100

Odor of No. 16642, faintly vegetable; of the others, none. —— The first sample was collected from a tubular test well in the valley of Crystal Brook, near the corner of Main and Howard streets, Saugus; the second and third, from a tubular test well near the corner of Main Street and the Newburyport turnpike, in Saugus; the fourth, from a tubular test well in rear of fire department building, Broadway, Revere; the last three, from a tubular well near junction of Washington and Fenno streets, Revere. The samples were collected in connection with an investigation for an additional water supply for Revere.

Microscopical Examination.

No organisms.

Water Supply of Rockland.

(See *Abington.*)

Water Supply of Rockport.

Chemical Examination of Water from Cape Pond, Rockport.

[Parts per 100,000.]

Number.	Date of Collection	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid							
		Turbidity.	Sediment.	Color.	Total	Loss on Ignition.	[illegible]	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15904	Jan. 20	Slight, milky.	Slight.	.33	12.65	2.00	.0004	.0158	.0144	.0014	5.35	.0070	.0001	.28	0.9
16092	Feb. 17	Decided.	Cons., rusty.	.43	12.40	3.00	.0000	.0214	.0150	.0064	5.39	.0000	.0000	.27	0.8
16259	Mar. 16	Distinct.	Slight.	.38	11.55	1.90	.0000	.0170	.0150	.0020	5.17	.0030	.0000	.27	1.3
16398	Apr. 13	Distinct.	Slight.	.20	10.55	1.95	.0004	.0188	.0122	.0066	4.80	.0090	.0000	.26	0.6
16615	May 18	Decided.	Slight.	.12	10.80	1.70	.0006	.0268	.0123	.0140	5.06	.0030	.0000	19	1.1
16823	June 17	Slight.	Slight, green.	.18	10.05	2.05	.0004	.0146	.0124	.0022	5.10	.0050	.0000	.16	0.9
16960	July 13	Distinct, milky.	Slight.	.30	12.25	2.05	.0004	.0182	.0138	.0044	5.00	.0000	.0001	.20	1.1
17212	Aug. 17	Slight.	V. slight.	.28	11.50	1.85	.0062	.0294	.0274	.0020	4.60	.0070	.0002	.26	0.9
17519	Sept. 21	V. slight.	V. slight.	.85	11.80	2.40	.0012	.0234	.0182	.0052	4.54	.0170	.0000	.23	0.9
17666	Oct. 19	Distinct.	Slight.	.25	11 80	2.25	.0000	.0208	.0154	.0054	4.62	.0000	.0000	.25	1.0
17868	Nov. 16	Distinct, milky.	Slight.	.50	12.45	2.40	.0002	.0148	.0118	.0030	5.00	.0030	.0001	.21	1.7
18014	Dec. 5	Distinct.	Slight.	.23	11.40	1.70	.0004	.0162	.0124	.0038	5.00	.0000	.0000	.27	1.1

ROCKPORT.

Chemical Examination of Water from Cape Pond, Rockport — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
–	1894	–	–	.22	12.85	1.91	.0001	.0225	.0163	.0062	5.55	.0010	.0000	.25	1.3
–	1895	–	–	.25	12.61	2.31	.0025	.0302	.0198	.0104	5.42	.0037	.0000	.32	1.3
–	1896	–	–	.29	11.67	2.11	.0008	.0198	.0149	.0049	4.97	.0089	.0000	.24	1.0

Note to analyses of 1896: Odor, generally distinctly vegetable, occasionally unpleasant, becoming stronger and also sweet or grassy on heating. —— The samples were collected from a faucet at the pumping station, with the exception of No. 16398, which was collected from the pond.

Microscopical Examination of Water from Cape Pond, Rockport.

[Number of organisms per cubic centimeter.]

	1896. Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	21	20	17	14	19	16	14	18	22	20	17	9
Number of sample,	15904	16092	16259	16398	16615	16823	16969	17212	17519	17666	17868	18014
PLANTS.												
Diatomaceæ,	820	7,600	1,504	1,586	1,144	904	28	0	52	501	280	412
Asterionella,	820	7,600	1,504	1,572	1,144	904	27	0	0	280	144	32
Cyclotella,	0	0	0	0	0	0	1	0	0	1	0	12
Melosira,	0	0	0	0	0	0	0	0	52	220	120	368
Synedra,	0	0	0	6	0	0	0	0	0	0	0	0
Tabellaria,	0	0	0	8	0	0	0	0	[illegible]	0	16	0
Cyanophyceæ, Anabæna,	0	0	0	0	1,552	0	[illegible]	20	0	1	0	0
Algæ,	0	0	60	0	6	368	10	17	412	628	312	568
Arthrodesmus,	0	0	0	0	2	272	0	4	0	2	0	4
Pediastrum,	0	0	0	0	2	2	2	0	0	0	0	0
Protococcus,	0	0	0	0	0	74	0	0	360	616	272	544
Raphidium,	0	0	0	0	0	10	0	5	8	2	8	12
Scenedesmus,	0	0	0	0	0	4	2	0	32	1	32	4
Staurastrum,	0	0	0	0	2	4	4	5	12	1	0	4
Staurogenia,	0	0	0	0	0	2	2	3	0	6	0	0
Zoöspores,	0	0	60	0	0	0	0	0	0	0	0	0
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	4	0	0	0	0	0	0	0	0
Infusoria,	1	19	1	54	2	101	0	34	4	0	4	8
Dinobryon,	0	0	0	14	2	1	0	0	0	0	0	0
Euglena,	0	0	0	0	0	100	0	0	0	0	0	0
Monas,	0	18	0	0	0	0	0	0	0	0	0	0
Peridinium,	1	1	1	40	0	0	0	2	0	0	0	8
Trachelomonas,	0	0	0	0	0	0	0	32	4	0	4	0
Vermes, Anuræa,	3	1	0	10	6	0	0	3	0	0	2	2
Crustacea,	.04	0	0	.02	0	0	.02	0	0	.04	0	[illegible]
Cyclops,	.04	0	0	0	0	0	.02	0	0	.04	0	0
Daphnia,	0	0	0	.02	0	0	0	0	0	0	0	0
Nauplius,	0	0	0	0	0	0	0	0	0	0	0	.02
Miscellaneous, Zoöglœa,	20	0	0	0	0	10	60	0	40	15	0	6
Total,	844	7,620	1,565	1,654	2,710	1,383	98	74	508	1,145	598	996

SALEM AND BEVERLY.

Water Supply of Salem and Beverly.

The character of the water of Wenham Lake has been affected during the years 1895 and 1896 by the mixture with it of water from the Longham Meadow Reservoir, which has a much higher color and contains more organic matter than the water of the lake.

Chemical Examination of Water from Wenhan Lake, in Beverly and Wenham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15878	Jan. 14	Slight, green.	Slight, green.	.20	6.35	1.65	.0028	.0322	.0156	.0166	.78	.0070	.0000	.29	2.7
16049	Feb. 11	V. slight.	Slight.	.16	6.50	2.25	.0028	.0170	.0152	.0018	.72	.0070	.0002	.31	2.9
16250	Mar. 13	V. slight.	Slight.	.12	6.25	1.70	.0012	.0152	.0138	.0014	.62	.0170	.0001	.26	2.5
16370	Apr. 6	Slight.	Slight.	.15	6.25	2.00	.0006	.0152	.0130	.0022	.73	.0100	.0001	.27	2.7
16568	May 12	Distinct.	Slight.	.16	6.10	1.90	.0004	.0174	.0138	.0036	.70	.0030	.0001	.30	2.6
16767	June 10	Slight.	Slight.	.18	5.70	1.40	.0024	.0208	.0188	.0020	.75	.0030	.0001	.36	2.6
16955	July 8	Distinct, green.	Slight, green.	.16	6.40	2.00	.0000	.0198	.0166	.0032	.82	.0060	.0000	.37	2.7
17175	Aug 11	Decided, white.	Slight.	.12	6.10	1.60	.0004	.0470	.0176	.0294	.81	.0000	.0001	.34	2.7
17427	Sept. 10	Slight.	Slight.	.10	6.95	2.50	.0002	.0186	.0148	.0038	.79	.0030	.0001	.21	2.7
17627	Oct. 12	Distinct, brown.	Cons., brown.	.07	6.55	1.85	.0040	.0194	.0148	.0046	.82	.0030	.0001	.23	2.7
17826	Nov. 10	Distinct.	Slight, green.	.15	6.50	2.10	.0086	.0192	.0162	.0030	.86	.0000	.0002	.33	2.9
18012	Dec. 7	Distinct.	Slight.	.16	5.90	0.90	.0000	.0138	.0116	.0022	.84	.0070	.0000	.18	3.1

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1887*	-	-	.05	4.73	0.82	.0025	.0133	-	-	.72	.0019	-	-	-
-	1888	-	-	.05	4.67	0.97	.0020	.0146	-	-	.73	.0068	.0001	-	-
-	1889	-	-	.06	4.23	1.05	.0014	.0173	.0138	.0035	.72	.0052	.0002	-	-
-	1890	-	-	.05	4.57	0.90	.0016	.0154	.0125	.0029	.74	.0104	.0001	-	2.5
-	1891	-	-	.07	4.70	1.12	.0008	.0147	.0113	.0034	.72	.0125	.0000	-	1.9
-	1892	-	-	.03	4.85	1.10	.0016	.0137	.0103	.0034	.75	.0077	.0000	-	2.2
-	1893	-	-	.04	5.49	1.26	.0033	.0130	.0100	.0030	.77	.0055	.0001	.16	2.6
-	1894	-	-	.07	6.69	1.53	.0030	.0148	.0114	.0034	.82	.0028	.0001	.14	3.0
-	1895	-	-	.21	6.75	1.97	.0026	.0177	.0146	.0031	.81	.0059	.0001	.30	3.1
-	1896	-	-	.15	6.30	1.83	.0020	.0213	.0152	.0061	.80	.0053	.0001	.28	2.7

* June to December.

NOTE to analyses of 1896: Odor, generally distinctly vegetable, becoming somewhat stronger and also sweetish on heating.——Nos. 15878, 16049, 16250, 17627 and 18012 were collected from a faucet at the pumping station; the others, from the lake.

For monthly record of height of water in this lake, see page 304.

SALEM AND BEVERLY.

Microscopical Examination of Water from Wenham Lake, in Beverly and Wenham.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	15	13	14	6	14	12	9	12	11	12	12	9
Number of sample,	15878	16049	16250	16370	16568	16767	16955	17175	17427	17627	17826	18012
PLANTS.												
Diatomaceæ,	466	978	453	336	1,306	1,291	142	18	35	230	3,268	410
Asterionella,	248	516	128	104	1,200	1,200	84	0	3	36	352	60
Cyclotella,	156	332	0	0	0	0	12	0	1	6	0	0
Fragilaria,	0	0	0	0	0	2	14	0	0	6	0	0
Melosira,	48	92	88	66	12	7	0	0	6	52	940	48
Stephanodiscus,	0	0	164	128	10	44	0	0	0	4	64	12
Synedra,	2	12	9	14	84	5	2	18	11	4	0	2
Tabellaria,	12	26	64	24	0	33	30	0	14	128	1,912	288
Cyanophyceæ,	0	0	0	0	0	27	308	3,922	60	0	12	0
Anabæna,	0	0	0	0	0	24	160	3,650	0	0	6	0
Cœlosphærium,	0	0	0	0	0	2	0	0	0	0	4	0
Microcystis,	0	0	0	0	0	1	148	272	60	0	2	0
Algæ,	10	0	1	6	16	8	262	10	82	[illegible]	1	0
Cœlastrum,	0	0	0	0	0	0	10	0	1	0	0	0
Cosmarium,	0	0	1	4	0	0	4	0	2	0	0	0
Protococcus,	8	0	0	2	14	7	238	8	72	10	1	0
Scenedesmus,	0	0	0	0	1	0	0	0	1	4	0	0
Staurastrum,	2	0	0	0	1	1	10	2	1	4	0	0
Staurogenia,	0	0	0	0	0	0	0	0	5	4	0	0
Fungi, Crenothrix,	0	0	0	0	0	10	0	0	0	0	0	0
ANIMALS.												
Infusoria,	5	0	0	6	96	30	2	2	6	8	17	2
Ceratium,	0	0	0	0	0	0	2	2	1	0	0	0
Dinobryon,	0	0	0	6	96	28	0	0	0	0	0	0
Mallomonas,	0	0	0	0	0	0	0	0	3	0	1	0
Paramæcium,	0	0	0	0	0	0	0	0	0	2	0	0
Synura,	5	0	0	0	0	0	0	0	0	0	0	0
Trachelomonas,	0	0	0	0	0	2	0	0	2	6	16	2
Vermes, Anuræa,	0	0	1	0	5	0	0	0	0	0	0	0
Crustacea, Daphnia,	0	0	0	0	0	0	0	0	0	.04	0	0
Miscellaneous,	0	0	0	0	5	0	40	[illegible]	40	60	10	5
Acarina,	0	0	0	0	0	0	0	.02	0	0	0	0
Zoöglœa,	0	0	0	0	5	0	40	20	40	60	10	5
TOTAL,	481	978	455	348	1,428	1,366	754	3,972	223	320	3,308	417

SALEM AND BEVERLY.

Table showing Heights of Water in Wenham Lake on the First of Each Month in 1896.

[NOTE. — High-water mark is 30.17 feet.]

DATE.	Height of Water.	DATE.	Height of Water.
1896.	Feet.	1896.	Feet.
Jan. 1,	27.67	July 1,	28.17
Feb. 1,	28.00	Aug. 1,	27.00
March 1,	29.31	Sept. 1,	25.96
April 1,	30.29	Oct. 1,	25.67
May 1,	29.83	Nov. 1,	25.42
June 1,	29.17	Dec. 1,	25.50

WATER SUPPLY OF SAUGUS.

(See *Lynn*.)

WATER SUPPLY OF SHARON.

Chemical Examination of Water from the Well of the Sharon Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
17150	1896. Aug. 10	None.	None.	.00	10.10	.0000	.0004	1.10	.2750	.0000	.02	3.2	.0060

NOTE to analysis of 1896: Odor, none, becoming faintly vegetable on heating. —— The sample was collected from a faucet at the pumping station, while pumping.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

SHEFFIELD.

The advice of the State Board of Health to the Sheffield Water Company, relative to taking water for the supply of the town of Sheffield from Iron Brook, which flows from Three Mile Pond in that town, may be found on pages 39 and 40 of this volume.

SHEFFIELD.

Chemical Examination of Water from Smith's and Clark's Springs in Sheffield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	[illegible]												
16560	May 9	None.	Slight.	.00	3.00	.0000	.0006	.12	.0070	.0000	.00	1.8	.0010
16561	May 9	V. slight	Slight.	.07	2.90	.0012	.0076	[illegible]	[illegible]	.0001	.04	1.5	–

Odor of the first sample, none, of the last, vegetable. —— The first sample was collected from Smith's Spring, near the junction of two brooks above the road from Sheffield to Hartsville; the second, from Clark's Spring, a short distance north of Smith's Spring.

Microscopical Examination.

An insignificant number of organisms was found in No. 16561; no organisms were found in the other sample.

Chemical Examination of Water from Iron Brook in Sheffield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved	Suspended.		Nitrates	Nitrites.		
	1896.														
16562	May 9	Slight.	Slight.	.72	7.25	2.15	.0062	.0252	.0230	.0022	.12	.0020	.0001	.58	4.7
16563	May 9	Slight.	Slight.	.70	7.60	2.10	.0020	.0210	.0195	.0012	.13	.0120	.0001	.67	4.9

Odor, vegetable; of the second sample, also mouldy. —— The first sample was collected from Iron Brook, about 500 feet below Three Mile Pond, the last, from Iron Brook, about one mile below Three Mile Pond.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows: No. 16562, 154; No. 16563, 89.

SHERBORN.

Chemical Examination of Water from Farm Pond in Sherborn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16908	June 29	Distinct.	Slight.	.06	1.80	0.70	.0000	.0136	.0128	.0008	.25	.0000	.0000	.26	0.0
17056	July 27	Slight, white.	Slight, white.	.02	1.55	0.66	.0000	.0136	.0128	.0008	.25	.0000	.0000	.15	0.0
17057	July 27	Slight, white.	Slight, white.	.03	1.80	0.66	.0000	.0144	.0106	.0038	26	.0020	.0000	11	0.0
17099	July 31	Distinct.	Slight.	.03	1.35	0.70	.0000	.0124	.0098	.0026	25	.0000	.0000	.15	0.0
17205	Aug 15	V. slight	V. slight.	.08	1.56	0.55	.0002	.0122	.0106	.0016	.22	.0000	.0000	.18	0.0
17353	Sept. 1	V. slight	V. slight.	.02	2.10	0.80	.0004	.0174	.0154	.0020	.26	.0000	.0000	.15	0.0

Odor of No. 17205, none, becoming faintly earthy on heating; of Nos. 17056 and 17099, decidedly disagreeable; of the others, faintly vegetable. — No. 17057 was collected from the pond, about 50 feet beneath the surface; the remaining samples were collected from the surface of the pond. The samples were collected during an investigation with reference to a new water supply for the Medfield Insane Asylum.

Microscopical Examination of Water from Farm Pond in Sherborn.

[Number of organisms per cubic centimeter.]

	1896.					
	June.	July.	July.	Aug.	Aug.	Sept.
Day of examination,	30	28	28	1	17	3
Number of sample,	16908	17056	17057	17099	17205	17353
PLANTS.						
Diatomaceæ,	65	[illegible]	6	50	40	10
Asterionella,	64	0	4	0	0	0
Synedra,	1	0	2	0	0	0
Tabellaria,	0	48	0	50	40	10
Cyanophyceæ,	72	0	7	3	2	21
Anabæna,	0	0	0	0	0	13
Microcystis,	72	0	7	3	2	8
Algæ,	0	4	30	1	18	9
Arthrodesmus,	0	2	0	1	10	1
Conferva,	0	2	0	0	0	0
Protococcus,	0	0	0	0	2	1
Raphidium,	0	0	30	0	5	7
Staurastrum,	0	0	0	0	1	0
ANIMALS.						
Infusoria,	18	10	4	8	1	0
Dinobryon,	0	0	4	6	0	0
Peridinium,	18	10	0	2	1	0

SHERBORN.

Microscopical Examination of Water from Farm Pond in Sherborn — Concluded.

[Number of organisms per cubic centimeter.]

	1896.					
	June.	July.	July.	Aug.	Aug.	Sept.
ANIMALS — Con.						
Vermes, Anuræa,	1	0	0	0	0	0
Miscellaneous,	.02	40	40	40	10	20
Acarina,	.02	0	0	0	0	0
Zoögloea,	0	40	40	40	10	20
TOTAL,	156	96	137	109	71	60

WATER SUPPLY OF SOMERVILLE.

(See *Boston, Mystic Works.*)

WATER SUPPLY OF SOUTHBRIDGE — SOUTHBRIDGE WATER SUPPLY COMPANY.

The works of the Southbridge Water Supply Company were enlarged in 1894 by the construction of a reservoir on Hatchet Brook in the southerly part of the town, from which water is supplied to the town by gravity. Much of the soil and vegetable matter is said to have been removed from the area covered with water. The reservoir has a watershed of 3 square miles, which contains a very small population.

Chemical Examination of Water from the Lower Reservoir of the Southbridge Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Alb[redacted]oid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16403	Apr. 14	Distinct	Slight.	.18	2.20	0.80	.0000	.0138	.0116	.0022	.16	.0030	.0000	.26	1.3
17166	Aug 11	Slight.	Cons.	.20	3.25	1.20	.0010	.0220	.0166	.0064	.13	.0030	.0000	.42	1.3

Odor of the first sample, none, becoming distinctly vegetable and sweetish on heating; of the last, distinctly vegetable. —— The first sample was collected from the reservoir, and the other from a faucet on Main Street supplied with water from this reservoir.

Microscopical Examination.

No. 16403. Diatomaceæ, *Melosira*, 10; *Navicula*, 9; *Synedra*, 26; *Tabellaria*, 11. Algæ, *Raphidium*, 6. Rhizopoda, *Actinophrys*, 1. Infusoria, *Dinobryon*, 9; *Peridinium*, 27. Vermes, *Anuræa*, 23. Total, 123.

No. 17166. Diatomaceæ, *Tabellaria*, 1. Algæ, *Conferva*, 2, *Sphærozosma*, 1. Infusoria, *Dinobryon*, 8; *Peridinium*, 10; *Trachelomonas*, 2. Vermes, *Anuræa*, 1. Miscellaneous, *Zoöglœa*, 60. Total, 60.

SOUTHBRIDGE.

Chemical Examination of Water from the Hatchet Brook Reservoir of the Southbridge Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16053	Feb. 11	V. slight.	Slight.	0.25	3.25	1.25	.0044	.0140	.0124	.0016	.10	.0020	.0008	0.50	0.8
17278	Aug 24	Distinct.	Slight.	0.70	4.10	2.35	.0000	.0346	.0310	.0036	.16	.0000	.0000	0.86	0.6
17446	Sept. 15	Decided, green.	Slight, green.	0.75	3.60	1.90	.0066	.0346	.0286	.0060	.16	.0070	.0000	–	0.9
17637	Oct. 13	V. slight.	Slight.	1.00	4.75	2.35	.0164	.0348	.0326	.0022	.19	.0070	.0002	1.05	1.3
17822	Nov. 10	Slight.	Slight.	0.90	4.90	2.50	.0044	.0340	.0320	.0020	.21	.0070	.0002	1.02	1.3
18015	Dec. 8	V. slight.	V. slight.	0.70	4.30	1.90	.0004	.0226	.0166	.0060	.24	.0030	.0002	0.79	0.8
Av.	....	....	....	0.74	4.17	2.04	.0050	.0291	.0255	.0036	.19	.0043	.0001	0.84	0.9

Odor, vegetable, sometimes none. —— The samples were collected from the reservoir.

Microscopical Examination of Water from the Hatchet Brook Reservoir of the Southbridge Water Works.

[Number of organisms per cubic centimeter.]

	1896. Feb.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	13	26	15	14	11	9
Number of sample,	16053	17278	17446	17637	17822	18018
PLANTS.						
Diatomaceæ,	36	7	122	4	8	16
Asterionella,	31	0	0	0	0	0
Cyclotella,	0	0	6	0	0	0
Meridion,	2	0	0	1	0	0
Synedra,	1	7	116	1	8	16
Tabellaria,	2	0	0	2	0	0
Algæ,	1	4	199	0	0	12
Protococcus,	0	4	141	0	0	0
Raphidium,	1	0	54	0	0	0
Scenedesmus,	0	0	4	0	0	0
Zoöspores,	0	0	0	0	0	12
ANIMALS.						
Infusoria,	0	8	6	0	0	2
Ciliated infusorian,	0	1	0	0	0	0
Euglena,	0	1	0	0	0	0
Monas,	0	3	0	0	0	0
Peridinium,	0	0	0	0	0	2
Phacus,	0	1	0	0	0	0
Trachelomonas,	0	2	6	0	0	0

SOUTHBRIDGE.

Microscopical Examination of Water from the Hatchet Brook Reservoir of the Southbridge Water Works — Concluded.

[Number of organisms per cubic centimeter.]

	1896.					
	Feb.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS — Con.						
Vermes, Asplanchna,	0	1	0	0	0	0
Crustacea, Daphnia,	0	0	0	.02	0	0
Miscellaneous, Zoöglœa,	0	0	60	0	0	0
TOTAL,	37	20	287	4	3	30

Chemical Examination of Water from Hatchet Pond, in Woodstock, Connecticut.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
17279	1896. Aug. 24	V. slight.	Slight.	.04	2.40	1.15	.0004	.0162	.0142	.0020	.18	.0020	.0000	.24	0.3

Odor, faintly mouldy, becoming faintly vegetable on heating.—The sample was collected from the pond, near its outlet. The pond is at the head of Hatchet Brook, on which the storage reservoir of the Southbridge Water Supply Company is located.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

Chemical Examination of Water from Glover Spring, Southbridge.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity	Sediment.	Color.		Free.	Albuminoid		Nitrates.	Nitrites.			
16747	1896. June 9	None.	None.	.02	5.10	.0000	.0040	.15	.0070	.0000	.00	3.1	.0050

Odor, none, becoming faintly mouldy on heating.—The sample was collected from a faucet in Southbridge supplied with water from Glover Spring. This spring is used as a source of supply for several families.

Microscopical Examination.

No organisms.

SPRINGFIELD.

WATER SUPPLY OF SPRINGFIELD.

Water from the Ludlow Reservoir was used for the supply of the city until July, 1896, at which time the taste and odor of the water became so objectionable that its use was discontinued. Water was pumped from Chapin Pond from July 7 until Sept. 7, 1896. During an investigation by the Board relative to the best method of preventing the occurrence of tastes and odors in the water of Ludlow reservoir, frequent samples of water from various sources in the vicinity were analyzed. The results of the analyses are given in the tables which follow.

Chemical Examination of Water from the Canal which conveys Water from Jabish, Axe Factory and Broad Brooks to the Receiving Basin of the Springfield Water Works, at Ludlow.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16932	July 6	Decided.	Slight.	.37	3.90	1.20	.0016	.0150	.0120	.0030	.11	.0010	.0001	–	1.5
17080	July 28	V. slight.	Slight.	.33	4.05	1.35	.0014	.0134	.0118	.0016	.14	.0020	.0000	.23	1.3
17179	Aug. 11	Slight.	Slight.	.55	4.65	1.55	.0006	.0122	.0108	.0014	.14	.0000	[redacted]	.50	1.7
17305	Aug. 26	Distinct.	Cons.	.28	3.25	1.60	.0000	.0400	.0238	.0162	.16	.0000	.0000	.39	1.0
17396	Sept. 5	Distinct	Cons.	.57	4.55	2.15	.0000	.0228	.0218	.0010	.16	.0020	.0000	.76	0.9
17523	Sept. 21	Distinct.	Slight.	.70	5.00	2.05	.0000	.0232	.0200	.0032	.20	.0020	.0000	.71	1.6
17604	Oct. 7	Slight.	Slight.	.68	4.35	2.00	.0004	.0266	.0248	.0018	.20	.0050	.0002	.85	1.3
17699	Oct. 21	Slight.	Cons.	.50	4.55	1.30	.0018	.0168	.0142	.0026	.21	.0030	.0001	.68	1.6
17811	Nov. 9	Slight.	Slight.	.68	4.35	1.70	.0008	.0192	.0176	.0016	.23	.0000	.0000	.90	1.3
17939	Nov. 21	Slight.	Slight.	.40	4.35	1.35	.0008	.0120	.0096	.0024	.26	.0030	.0000	.46	1.6
18021	Dec. 6	V. slight.	Slight.	.40	3.70	1.05	.0004	.0112	.0090	.0022	.22	.0050	.0000	.44	1.3
18195	Dec. 21	Slight.	Slight.	.30	4.10	1.10	.0010	.0108	.0086	.0022	.21	.0050	.0001	.39	1.4
Av.*	....	....	....	.46	4.21	1.55	.0007	.0186	.0153	.0033	.18	.0027	.0000	.52	1.3

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, vegetable and frequently mouldy.——The samples were collected from the canal, at its entrance into the receiving basin.

SPRINGFIELD.

Microscopical Examination of Water from the Canal which conveys Water from Jabish, Axe Factory and Broad Brooks to the Receiving Basin of the Springfield Water Works, at Ludlow.

[Number of organisms per cubic centimeter.]

	1896.											
	July.	July	Aug	Aug	Sept.	Sept.	Oct.	Oct.	Nov	Nov	Dec.	Dec
Day of examination,	8	30	13	27	9	22	9	23	11	24	10	26
Number of sample,	16932	17080	17179	17208	17396	17528	17604	17699	17811	17930	18021	18196
PLANTS.												
Diatomaceæ,	218	140	72	596	26	116	126	104	72	16	31	[illegible]
Asterionella,	208	76	0	16	4	0	0	0	0	0	0	0
Cocconeis,	0	0	0	0	0	0	4	[illegible]	0	0	0	0
Cymbella,	0	0	0	0	1	0	4	4	2	0	0	0
Diatoma,	0	0	0	0	6	8	0	0	0	0	0	0
Epithemia,	0	0	0	0	0	12	0	0	0	0	0	0
Fragilaria,	0	2	42	0	0	0	0	0	10	0	0	0
Melosira,	0	34	12	80	2	0	6	80	20	0	0	0
Meridion,	0	0	0	0	0	12	10	0	2	0	0	8
Navicula,	9	8	4	0	5	32	8	4	22	4	4	4
Pinnularia,	0	0	2	0	1	0	0	0	4	0	1	0
Surirella,	0	0	0	0	0	4	0	4	0	0	4	0
Synedra,	1	20	12	500	4	48	92	0	10	10	14	30
Tabellaria,	0	0	0	0	4	0	0	8	2	2	2	0
Cyanophyceæ,	2	0	0	144	0	0	0	0	0	0	0	0
Anabæna,	2	0	0	44	0	0	0	0	0	0	0	0
Cœlosphærium,	0	0	0	100	0	0	0	0	0	0	0	0
Algæ,	9	60	2	2,892	1	0	2	4	0	0	0	0
Pediastrum,	1	0	0	80	0	0	0	0	0	0	0	0
Protococcus,	0	18	0	1,600	0	0	0	0	0	0	0	0
Scenedesmus,	0	0	0	1,200	0	0	2	4	0	0	0	0
Staurastrum,	0	2	2	12	0	0	0	0	0	0	0	0
Staurogenia,	8	40	0	0	1	0	0	0	0	0	0	0
ANIMALS.												
Infusoria,	2	2	0	4	0	0	0	1	0	0	0	0
Euglena,	2	0	0	0	0	0	0	0	0	0	0	0
Peridinium,	0	2	0	0	0	0	0	0	0	0	0	0
Trachelomonas,	0	0	0	4	0	0	0	1	0	0	0	0
Vermes,	0	0	0	16	0	0	0	0	0	0	0	0
Anuræa,	0	0	0	4	0	0	0	0	0	0	0	0
Rotifer,	0	0	0	12	0	0	0	0	0	0	0	0
Crustacea,	0	0	0	.16	0	0	0	0	0	0	0	[illegible]
Daphnia,	0	0	0	.14	0	0	0	0	0	0	0	0
Entomostracan ova,	0	0	0	.02	0	0	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	5	40	120	100	40	20	60	0	40	0	30	60
TOTAL,	236	242	194	3,752	67	136	188	109	112	16	61	102

SPRINGFIELD.

Chemical Examination of Water from the Receiving Basin of the Springfield Water Works, at Ludlow.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
15872	Jan. 13	V. slight.	V. slight	.35	3.35	1.05	.0008	.0104	.0086	.0018	.18	.0130	.0000	.30	0.9
16029	Feb. 10	Slight, clayey.	Slight.	.35	3.65	1.15	.0006	.0146	.0134	.0012	.10	.0070	.0001	.48	1.1
16218	Mar. 9	Slight.	Slight.	.35	3.25	1.10	.0022	.0156	.0138	.0018	.10	.0120	.0000	.45	0.8
16396	Apr 13	Slight.	Slight.	.30	2.85	1.15	.0000	.0116	.0100	.0016	.12	.0080	.0000	.38	1.0
16560	May 10	Distinct	Slight.	.40	2.50	0.85	.0020	.0166	.0130	.0036	.17	.0030	.0000	.42	0.7
16748	June 9	Distinct.	Slight.	.70	3.90	1.70	.0038	.0276	.0242	.0034	.11	.0030	.0001	.61	1.3
16838	June 16	Slight, green.	Slight.	.62	3.95	1.45	.0014	.0216	.0174	.0042	.10	.0000	.0001	.19	1.3
16933	July 6	Decided	Cons., brown.	.43	3.65	1.50	.0048	.0320	.0206	.0114	.12	.0050	.0000	–	0.9
16966	July 13	Distinct.	Cons., brown.	.45	4.20	1.60	.0018	.0236	.0174	.0062	.10	.0000	.0000	–	1.4
17061	July 26	Distinct.	Slight.	.33	3.80	1.40	.0036	.0246	.0184	.0062	.14	.0020	.0000	.53	1.1
17160	Aug. 11	Decided, green.	Cons., green.	.35	4.65	1.90	.0002	.0266	.0180	.0088	.16	.0000	.0000	.89	1.7
17309	Aug. 26	Distinct	Cons.	.40	3.65	1.55	.0000	.0172	.0150	.0022	.16	.0000	.0000	.41	1.2
17395	Sept. 8	Distinct.	Cons.	.55	4.45	2.15	.0006	.0254	.0210	.0044	.18	.0030	.0000	.69	1.3
17529	Sept. 21	Decided	Slight.	.65	4.45	1.90	.0000	.0254	.0200	.0054	.19	.0020	.0001	.79	1.3
17696	Oct. 7	Slight.	Slight.	.60	3.90	1.60	.0000	.0260	.0244	.0016	.19	.0000	.0001	.75	1.3
17700	Oct. 21	Slight.	Slight.	.60	4.35	1.45	.0014	.0180	.0166	.0024	.21	.0080	.0001	.66	1.6
17812	Nov. 9	Slight.	Slight.	.66	4.45	1.65	.0004	.0214	.0196	.0016	[illegible]	[illegible]	.0001	.96	1.1
17940	Nov. 21	Slight.	Slight.	.37	3.85	1.40	.0010	.0114	.0092	.0022	.22	.0050	.0001	.42	1.3
18022	Dec. 8	V. slight.	V. slight.	.40	3.95	1.05	.0008	.0118	.0096	.0022	.19	.0070	.0000	.46	1.2
18196	Dec. 21	V. slight.	Slight.	.35	4.25	1.45	.0010	.0126	.0114	.0012	.22	.0060	.0001	.41	1.4

Averages by Years.

–	1891	–	–	.31	3.27	1.20	.0011	.0225	.0147	.0078	.09	.0049	.0001	–	1.0
–	1892	–	–	.44	3.79	1.30	.0004	.0164	.0127	.0037	.14	.0089	.0001	–	1.3
–	1893	–	–	.49	3.76	1.39	.0009	.0204	.0146	.0058	.15	.0026	.0001	.51	1.2
–	1894	–	–	.49	3.68	1.42	.0010	.0196	.0151	.0045	.16	.0027	.0000	.46	1.6
–	1895	–	–	.47	3.86	1.61	.0019	.0212	.0162	.0050	.18	.0050	.0000	.50	1.3
–	1896*	–	–	.43	3.71	1.37	.0012	.0182	.0150	.0032	.15	.0051	.0000	.60	1.1

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1896: Odor, distinctly vegetable, becoming stronger and also mouldy or grassy on heating. —— The samples were collected from the basin, near the surface.

SPRINGFIELD.

Microscopical Examination of Water from the Receiving Basin of the Springfield Water Works, at Ludlow.

[Number of organisms per cubic centimeter.]

	1896.									
	Jan.	Feb.	Mar.	Apr.	May.	June.	June.	July	July.	July.
Day of examination,	15	11	10	14	12	10	19	6	14	30
Number of sample,	15872	16029	16218	16396	16569	16748	16838	16938	16966	17061
PLANTS.										
Diatomaceæ,	11	8	8	86	92	168	204	155	206	564
Asterionella,	0	4	0	0	11	51	116	60	69	176
Cyclotella,	0	0	0	0	0	0	0	2	0	32
Cymbella,	0	0	0	24	2	0	0	0	0	0
Diatoma,	2	0	0	0	0	0	0	0	0	0
Fragilaria,	0	0	0	0	4	0	0	6	45	0
Melosira,	0	0	0	5	4	0	8	20	28	152
Meridion,	0	0	0	0	0	0	0	0	0	0
Navicula,	3	0	0	4	24	3	2	1	2	4
Pinnularia,	0	0	0	0	1	0	0	0	0	0
Surirella,	0	0	0	0	0	0	0	0	0	2
Synedra,	4	3	4	44	44	2	0	0	0	74
Tabellaria,	2	1	4	8	2	112	78	64	62	124
Cyanophyceæ,	0	0	0	0	0	60	88	200	2	10
Anabæna,	0	0	0	0	0	60	88	200	2	8
Cœlosphærium,	0	0	0	0	0	0	0	0	0	2
Algæ,	0	0	0	0	2	2	14	12	9	273
Cœlastrum,	0	0	0	0	0	1	2	0	0	10
Pediastrum,	0	0	0	0	0	0	0	0	1	60
Protococcus,	0	0	0	0	0	0	12	0	5	56
Raphidium,	0	0	0	0	0	0	0	0	0	0
Scenedesmus,	0	0	0	0	2	1	0	3	2	64
Selenastrum,	0	0	0	0	0	0	0	5	0	11
Staurastrum,	0	0	0	0	0	0	0	0	1	72
Staurogenia,	0	0	0	0	0	0	0	4	0	0
ANIMALS.										
Infusoria,	0	0	140	4	24	1	[redacted]	7	62	22
Dinobryon,	0	0	140	0	23	0	82	0	59	0
Euglena,	0	0	0	0	0	0	0	0	1	2
Mallomonas,	0	0	0	0	0	1	0	0	0	0
Monas,	0	0	0	0	0	0	0	0	0	0
Peridinium,	0	0	0	4	0	0	0	1	0	0
Synura,	0	0	0	0	0	0	0	1	1	0
Trachelomonas,	0	0	0	0	1	0	0	0	1	20
Vorticella,	0	0	0	0	0	0	0	5	0	0
Vermes, Anuræa,	0	0	0	0	0	0	0	1	0	0
Crustacea,	0	0	0	0	0	.02	0	.16	.14	0
Cyclops,	0	0	0	0	0	0	0	.04	.08	0
Daphnia,	0	0	0	0	0	.02	0	.12	.06	0
Miscellaneous,	0	0	0	0	80	.02	40	5	40	100
Acarina,	0	0	0	0	0	.02	0	.04	.06	0
Zoöglœa,	0	0	0	0	80	0	40	5	40	100
TOTAL,	11	8	148	92	198	231	428	380	319	969

SPRINGFIELD.

Microscopical Examination of Water from the Receiving Basin of the Springfield Water Works, at Ludlow — Concluded.

[Number of organisms per cubic centimeter.]

	1896.									
	Aug.	Aug.	Sept.	Sept.	Oct.	Oct.	Nov.	Nov.	Dec.	Dec.
Day of examination,	13	27	9	22	9	23	11	24	10	28
Number of sample,	17180	17209	17305	17529	17605	17700	17812	17940	18022	18198
PLANTS.										
Diatomaceæ,	56	62	[illegible]	470	[illegible]	162	42	56	46	[illegible]
Asterionella,	0	5	30	0	0	0	0	0	0	0
Cyclotella,	0	0	0	0	4	0	0	0	0	0
Cymbella,	1	0	0	0	2	0	0	0	0	0
Diatoma,	0	0	6	8	0	0	0	0	4	0
Fragilaria,	10	0	7	0	0	0	0	12	0	0
Melosira,	0	14	24	96	10	86	22	8	4	0
Meridion,	0	2	0	0	4	0	0	10	0	0
Navicula,	0	6	1	4	8	8	6	6	6	0
Pinnularia,	0	4	2	0	4	0	0	0	2	0
Surirella,	0	0	1	0	2	0	0	0	6	0
Synedra,	45	24	64	302	132	68	8	20	12	12
Tabellaria,	0	4	3	10	0	0	6	0	12	0
Cyanophyceæ,	61	0	[illegible]	44	0	0	0	0	0	0
Anabæna,	52	0	22	16	0	0	0	0	0	0
Cœlosphærium,	9	0	9	28	0	0	0	0	0	0
Algæ,	[illegible]	24	[illegible]	130	10	2	0	[illegible]	0	[illegible]
Cœlastrum,	0	0	0	0	0	0	0	0	0	0
Pediastrum,	66	2	1	4	2	0	0	2	0	0
Protococcus,	100	0	1	0	0	0	0	0	0	1
Raphidium,	0	0	7	28	0	0	0	0	0	0
Scenedesmus,	1,200	4	18	80	8	2	0	4	0	2
Selenastrum,	0	6	0	10	0	0	0	0	0	0
Staurastrum,	24	0	2	8	0	0	0	0	0	0
Staurogenia,	4	12	10	0	0	0	0	0	0	0
ANIMALS.										
Infusoria,	0	0	4	10	4	0	2	2	2	0
Dinobryon,	0	0	0	0	0	0	0	0	0	0
Euglena,	0	0	1	0	0	0	0	0	0	0
Mallomonas,	0	0	0	0	0	0	0	2	0	0
Monas,	0	0	0	2	0	0	0	0	2	0
Peridinium,	0	0	0	0	4	0	0	0	0	0
Synura,	0	0	0	0	0	0	0	0	0	0
Trachelomonas,	0	0	3	8	0	0	2	0	0	0
Vorticella,	0	0	0	0	0	0	0	0	0	0
Vermes, Anuræa,	0	0	1	0	0	[illegible]	0	0	0	0
Crustacea,	0	0	0	0	0	[illegible]	0	0	0	[illegible]
Cyclops,	0	0	0	0	0	0	0	0	0	[illegible]
Daphnia,	0	0	0	0	0	0	0	0	0	[illegible]
Miscellaneous,	60	[illegible]	80	60	60	120	40	5	[illegible]	50
Acarina,	0	0	0	0	0	0	0	0	0	0
Zoöglœa,	60	20	80	60	60	120	40	[illegible]	30	50
TOTAL,	1,573	106	293	714	240	284	84	69	78	65

SPRINGFIELD.

Chemical Examination of Water from the Receiving Basin of the Springfield Water Works, at Ludlow, collected Seven Feet beneath the Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16839	June 18	Slight, green.	Cons., brown.	.52	4.25	1.70	.0014	.0172	.0152	.0020	.09	.0020	.0000	.23	1.3

Odor, faintly vegetable.

Microscopical Examination.

No. 16839. Diatomaceæ, *Asterionella*, 124; *Fragilaria*, 4; *Melosira*, 4; *Meridion*, 4; *Navicula*, 6; *Synedra*, 20; *Tabellaria*, 64. Cyanophyceæ, *Anabæna*, 32. Algæ, *Protococcus*, 1; *Staurogenia*, 3. Total, [illegible].

Chemical Examination of Water from Ludlow Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15871	Jan. 13	Slight.	Slight.	.53	3.20	1.45	.0032	.0178	.0166	.0012	.17	.0100	.0000	.42	0.9
16028	Feb. 10	Distinct.	V. slight	.28	3.85	1.20	.0020	.0230	.0162	.0068	.13	.0070	.0001	.45	1.6
16217	Mar. 9	Decided	Slight.	.30	3.10	1.15	.0010	.0262	.0168	.0094	.08	.0030	.0000	.42	1.0
16396	Apr. 13	Distinct.	Slight.	.23	3.00	1.25	.0062	.0164	.0122	.0042	.14	.0020	.0001	.35	0.6
16570	May 10	Distinct.	Cons.	.25	2.80	1.05	.0068	.0272	.0184	.0088	.17	.0020	.0000	.34	0.8
16749	June 9	Decided, green	Slight, green.	.30	2.90	1.20	.0004	.1086	.0308	.0778	.15	.0030	.0001	.39	1.0
16836	June 15	Decided, green	Slight.	.30	2.95	1.20	.0000	.0706	.0252	.0454	.17	.0000	.0000	.29	0.6
16934	July 6	Decided, green.	Cons., rusty.	.50	4.20	2.10	.0274	.0718	.0430	.0288	.12	.0050	.0000	–	1.0
16967	July 13	Distinct.	Cons., brown.	.45	3.75	1.75	.0390	.0426	.0358	.0068	.10			–	1.1
17082	July 28	Distinct, green	Cons., green.	.27	2.90	1.25	.0136	.0408	.0324	.0084	.16	.0030	.0001	.27	1.0
17181	Aug. 11	Decided, green.	Cons., green.	.32	4.10	1.90	.0000	.0390	.0200	.0130	.16	.0000	.0000	.46	1.0
17306	Aug. 26	Distinct.	Cons.	.30	3.70	1.50	.0000	.0290	.0148	.0142	.15	.0000	.0001	.34	1.3
17397	Sept. 8	Decided, green	Cons.	.22	3.70	2.20	.0000	.0406	.0214	.0192	.18	.0000	.0001	.33	0.8
17530	Sept. 21	Decided.	Cons., green.	.20	3.15	1.65	.0000	.0446	.0204	.0242	.17	.0020	.0000	.40	1.1
17606	Oct. 7	Distinct, green.	Cons.	.20	2.90	1.55	.0004	.0742	.0302	.0440	.20	.0000	.0002	.38	0.8

SPRINGFIELD.

Chemical Examination of Water from Ludlow Reservoir — Concluded.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
17701	Oct. 21	Decided.	Cons., yellow.	.20	3.55	1.70	.0010	.0580	.0238	.0342	16	.0030	.0001	.55	1.3
17813	Nov. 9	Distinct.	Cons., green.	.20	2.95	1.40	.0006	.0578	.0224	.0354	15	.0030	.0001	.37	1.1
17941	Nov. 21	Decided.	Slight.	.17	2.85	1.45	.0006	.0558	.0266	.0292	19	.0030	.0001	.32	0.9
18023	Dec. 8	Slight.	Slight.	.20	2.95	1.30	.0022	.0312	.0238	.0074	.20	.0030	.0001	.28	1.2
18197	Dec. 21	Slight.	Slight.	.17	3.25	1.35	.0120	.0344	.0278	.0066	.22	.0030	.0001	.28	0.9

Averages by Years.

-	1876-77*	-	-	-	4.56	-	.0139	.0426	.0296	.0130	-	-	-	-	-
-	1887†	-	-	.24	3.43	1.56	.0030	.0486	-	-	.15	.0019	-	-	-
-	1888	-	-	.13	2.91	1.20	.0019	.0332	-	-	.12	.0047	.0001	-	-
-	1889	-	-	.12	2.42	1.06	.0028	.0461	.0237	.0224	10	.0038	.0002	-	-
-	1890	-	-	.15	2.96	1.54	.0029	.0387	.0210	.0177	10	.0085	.0001	-	0.9
-	1891	-	-	.20	3.00	1.42	.0050	.0425	.0228	.0197	.09	.0050	.0001	-	0.8
-	1892‡	-	-	.26	3.41	1.41	.0006	.0277	.0189	.0088	13	.0049	.0001	-	1.0
-	1893§	-	-	.47	4.11	2.03	.0011	.0375	.0259	.0116	14	.0019	.0001	.58	1.2
-	1894	-	-	.37	3.29	1.47	.0009	.0221	.0165	.0056	16	.0018	.0000	.42	1.1
-	1895	-	-	.29	3.35	1.56	.0028	.0316	.0201	.0114	.18	.0030	.0000	.41	1.1
-	1896‖	-	-	.26	3.26	1.41	.0042	.0404	.0220	.0184	15	.0031	.0000	.37	1.0

* These analyses were made by Prof. William R. Nichols, for the city of Springfield, from samples collected about once a week, between July 1, 1876, and Sept. 30, 1877.

† June to December. ‡ January to September. § May to December.

‖ Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1896 Odor, decidedly grassy and mouldy, occasionally vegetable and sweetish, rarely unpleasant. On heating, the odor became stronger and decidedly sweet and grassy.—The samples were collected from the reservoir, 2 or 3 feet beneath the surface. For monthly record of height of water, see page 321.

SPRINGFIELD.

Microscopical Examination of Water from Ludlow Reservoir.

[Number of organisms per cubic centimeter

	1896.									
	Jan.	Feb.	Mar	Apr.	May.	June.	June.	July.	July.	July.
Day of examination,	15	11	10	14	12	10	19	8	14	30
Number of sample,	15871	16028	16217	16295	16570	16749	16838	16934	16967	17082
PLANTS.										
Diatomaceæ,	3	0	0	522	321	28	30	8	10	112
Asterionella,	0	0	0	164	3	0	0	0	0	32
Cyclotella,	0	0	0	0	1	0	0	1	0	0
Diatoma,	0	0	0	0	0	0	0	0	0	0
Fragilaria,	0	0	0	136	0	0	0	5	0	0
Melosira,	0	0	0	8	26	19	24	0	0	0
Nitzschia,	0	0	0	0	0	0	0	0	0	0
Synedra,	3	0	0	196	35	4	0	2	2	80
Tabellaria,	0	0	0	18	256	5	6	0	0	0
Triceratium,	0	0	0	0	0	0	0	0	8	0
Cyanophyceæ,	0	0	0	2	32	812	1,004	304	8	30
Anabæna,	0	0	0	2	32	812	1,000	300	2	4
Clathrocystis,	0	0	0	0	0	0	0	4	6	6
Cœlosphærium,	0	0	0	0	0	0	0	0	0	20
Microcystis,	0	0	0	0	0	0	4	0	0	0
Algæ,	18	0	0	2	20	3	4	25	84	730
Arthrodesmus,	0	0	0	0	0	0	0	0	16	0
Chlorococcus,	0	0	0	0	0	0	0	0	0	0
Cœlastrum,	0	0	0	0	0	0	0	0	0	20
Cosmarium,	0	0	0	0	0	0	0	0	0	0
Dictyosphærium,	1	0	0	0	0	0	0	0	0	28
Pediastrum,	0	0	0	0	4	2	0	5	2	80
Protococcus,	0	0	0	0	4	0	0	0	10	256
Raphidium,	1	0	0	0	0	0	0	0	0	0
Scenedesmus,	3	0	0	2	5	1	0	17	44	168
Selenastrum,	0	0	0	0	1	0	0	0	6	6
Staurastrum,	4	0	0	0	6	0	4	2	2	172
Staurogenia,	2	0	0	0	0	0	0	1	0	0
Zoöspores,	7	0	0	0	0	0	0	0	4	0
Fungi, Crenothrix,	0	0	0	0	0	0	0	40	0	0
ANIMALS.										
Rhizopoda,	0	0	0	4	0	0	0	0	0	0
Actinophrys,	0	0	0	2	0	0	0	0	0	0
Arcella,	0	0	0	2	0	0	0	0	0	0
Infusoria,	524	4,866	3,301	344	733	0	0	1	2	8
Ciliated infusorian,	0	0	1	0	0	0	0	0	0	0
Cryptomonas,	0	0	0	0	0	0	0	0	0	0
Dinobryon,	520	4,860	3,300	336	732	0	0	0	0	0
Monas,	0	0	0	0	0	0	0	0	0	0
Peridinium,	4	6	0	6	0	0	0	1	0	0
Synura,	0	0	0	0	0	0	0	0	0	0
Tintinnidium,	0	0	0	0	0	0	0	0	2	0
Trachelomonas,	0	0	0	0	1	0	0	0	0	6
Vorticella,	0	0	0	2	0	0	0	0	0	[illegible]
Vermes,	8	0	1	36	0	0	0	5	6	0
Anuræa,	1	0	0	36	0	0	0	5	6	0
Asplanchna,	0	0	1	0	0	0	0	0	0	0
Rotifer,	7	0	0	0	0	0	0	0	0	0
Crustacea,	.04	0	0	.02	.8	0	.02	.34	.06	.12
Bosmina,	0	0	0	0	0	0	0	0	0	0
Cyclops,	0	0	0	0	0	0	0	.10	0	.12
Daphnia,	.04	0	0	.02	.8	0	.02	.24	.06	0
Miscellaneous,	0	0	0	0	120	0	.08	10	[illegible]	160
Acarina,	0	0	0	0	0	0	.08	.12	.06	0
Zoöglœa,	0	0	0	0	120	0	0	10	[illegible]	160
TOTAL,	553	4,886	3,302	910	1,232	848	1,038	483	170	1,035

SPRINGFIELD.

Microscopical Examination of Water from Ludlow Reservoir — Concluded.

[Number of organisms per cubic centimeter.]

	1896.									
	Aug.	Aug.	Sept.	Sept.	Oct.	Oct.	Nov.	Nov.	Dec.	Dec.
Day of examination,	13	27	9	23	9	23	10	24	10	26
Number of sample,	17181	17306	17397	17530	17606	17701	17818	17941	18023	18197
PLANTS.										
Diatomaceæ,	89	148	2,792	[illegible]	1,388	1,760	616	314	348	66
Asterionella,	25	88	500	0	32	64	22	166	116	48
Cyclotella,	0	0	0	0	0	0	0	0	28	0
Diatoma,	0	0	24	8	0	0	0	0	8	0
Fragilaria,	0	32	0	0	0	0	0	120	0	0
Melosira,	0	0	236	32	96	16	102	0	16	0
Nitzschia,	0	0	0	0	0	0	0	0	0	16
Synedra,	64	16	2,180	2,960	1,260	1,680	492	24	180	0
Tabellaria,	0	0	0	16	0	0	0	0	0	0
Triceratium,	0	0	0	0	0	0	0	2	0	0
Cyanophyceæ,	90	73	292	260	912	446	492	408	50	2
Anabæna,	18	56	148	116	780	280	384	320	16	0
Clathrocystis,	12	1	16	8	4	0	0	0	0	0
Cœlosphærium,	60	14	128	136	128	166	108	80	32	2
Microcystis,	0	2	0	0	0	0	0	8	2	0
Algæ,	5,096	986	688	350	40	224	180	552	92	104
Arthrodesmus,	0	0	0	0	0	0	0	0	0	0
Chlorococcus,	0	0	0	0	0	0	0	48	4	0
Cœlastrum,	0	2	8	8	0	0	0	8	0	0
Cosmarium,	0	0	16	0	0	0	0	8	0	0
Dictyosphærium,	0	0	0	0	0	0	8	0	0	0
Pediastrum,	32	52	48	16	4	0	4	0	4	0
Protococcus,	1,000	300	104	88	8	32	14	280	32	64
Raphidium,	0	20	84	64	0	32	0	16	0	0
Scenedesmus,	4,000	600	264	104	8	24	98	160	32	40
Selenastrum,	0	0	36	0	0	0	2	0	0	0
Staurastrum,	36	8	44	48	4	8	12	32	8	0
Staurogenia,	28	8	56	32	16	128	38	0	0	0
Zoöspores,	0	0	0	0	0	0	0	0	2	0
Fungi, Crenothrix,	0	0	0	0	0	0	0	0	0	0
ANIMALS.										
Rhizopoda,	0	0	0	0	0	0	0	0	0	0
Actinophrys,	0	0	0	0	0	0	0	0	0	0
Arcella,	0	0	0	0	0	0	0	0	0	0
Infusoria,	0	6	44	46	0	16	[illegible]	8	30	[illegible]
Ciliated infusorian,	0	0	0	0	0	0	0	0	4	0
Cryptomonas,	0	0	0	0	0	0	0	0	4	0
Dinobryon,	0	0	0	0	0	8	0	0	12	36
Monas,	0	0	0	0	0	0	0	8	0	0
Peridinium,	0	2	0	0	0	8	8	0	8	0
Synura,	0	2	0	0	0	0	0	0	0	0
Tintinnidium,	0	0	0	0	0	0	0	0	0	0
Trachelomonas,	0	2	44	46	8	8	14	0	0	0
Vorticella,	0	0	0	0	0	0	0	0	2	0
Vermes,	0	0	0	0	0	0	2	0	4	0
Anuræa,	0	0	0	0	0	0	0	0	0	0
Asplanchna,	0	0	0	0	0	0	2	0	4	0
Rotifer,	0	0	0	0	0	0	0	0	0	0
Crustacea,	0	.12	0	.04	0	.12	.06	0	.04	0
Bosmina,	0	0	0	0	0	0	.02	0	0	0
Cyclops,	0	0	0	.04	0	0	.04	0	.04	0
Daphnia,	0	.12	0	0	0	.12	0	0	0	0
Miscellaneous,	60	60	120	[illegible]	80	0	[illegible]	200	140	100
Acarina,	0	0	0	.04	0	0	0	0	0	.02
Zoöglœa,	60	60	120	80	80	0	80	200	140	100
TOTAL,	5,328	1,277	3,904	3,756	2,428	2,446	1,360	1,482	664	306

SPRINGFIELD.

Chemical Examination of Water from Ludlow Reservoir, collected near the Bottom.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16637	June 16	Distinct, green.	Slight.	.32	3.05	1.15	.0040	.0292	.0196	.0096	.18	.0020	.0000	.14	0.7
16935	July 6	Decided.	Cons., rusty.	.48	3.85	2.10	.0348	.0740	.0508	.0232	.14	.0090	.0000	–	0.8
17083	July 28	Slight, green.	Cons., green.	.30	3.60	1.75	.0228	.0442	.0292	.0150	.14	.0000	.0001	.46	0.9
17182	Aug. 11	Decided, green	Cons., green.	.38	3.95	1.90	.0000	.0502	.0292	.0210	.16	.0000	.0000	.43	0.9
17307	Aug 26	Distinct.	Cons.	.28	3.10	1.65	.0000	.0386	.0214	.0172	.16	.0000	.0000	.43	0.9
17398	Sept. 8	Decided, green.	Cons.	.23	3.65	1.95	.0000	.0398	.0222	.0176	.18	.0000	.0000	.37	0.8
17531	Sept. 21	Decided, green	Cons., green.	.30	3.05	1.65	.0000	.0512	.0218	.0294	.15	.0000	.0001	.46	0.9
17607	Oct. 7	Distinct, green.	Cons.	.24	2.90	1.30	.0000	.0718	.0270	.0448	.21	.0030	.0008	.41	0.9
17702	Oct. 21	Decided.	Cons., yellow.	.22	3.45	1.56	[illegible]	.0788	.0232	.0556	.18	.0030	.0001	.38	0.9
17814	Nov 9	Distinct.	Cons., green.	.20	3.05	1.45	.0002	.0582	.0252	.0330	.16	.0060	.0001	.32	1.0
17942	Nov. 21	Decided.	Slight.	.18	3.00	1.55	[illegible]	.0524	.0276	.0248	.15	.0020	.0000	.32	0.8
18024	Dec. 6	Slight.	Slight.	.22	3.15	1.35	.0032	.0272	.0240	.0032	.19	.0020	.0001	.34	1.0
18198	Dec. 21	Distinct.	Slight.	.15	3.10	1.40	.0114	.0314	.0266	.0048	.18	.0030	.0002	.36	0.7
Av.*	....	....	....	.26	3.28	1.56	.0069	.0483	.0262	.0221	.17	.0021	.0000	.36	0.8

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, generally decidedly mouldy and grassy, occasionally vegetable and unpleasant. —— The samples were collected from the reservoir, near the bottom.

Microscopical Examination of Water from Ludlow Reservoir, collected near the Bottom.

[Number of organisms per cubic centimeter.]

	1896.												
	June.	July	July.	Aug	Aug.	Sept.	Sept.	Oct	Oct.	Nov	Nov.	Dec.	Dec.
Day of examination, . .	19	6	30	13	27	9	23	9	23	10	24	10	26
Number of sample, . .	16637	16935	17083	17182	17307	17398	17531	17607	17702	17814	17942	18024	18198
PLANTS.													
Diatomaceæ, . . .	78	17	370	158	228	2,916	2,632	1,720	2,432	832	528	284	68
Asterionella, . . .	16	0	120	16	0	156	0	16	32	32	128	152	40
Fragilaria, . . .	0	0	0	0	0	0	0	0	0	0	400	0	0
Melosira, . . .	48	15	206	32	22	316	72	12	0	200	0	28	6
Navicula, . . .	2	0	0	0	0	0	0	0	0	4	0	4	2
Nitzschia, . . .	0	0	0	0	0	0	0	0	0	0	0	0	14
Synedra, . . .	4	2	44	110	206	2,440	2,560	1,680	2,400	596	24	100	4
Tabellaria, . . .	8	0	0	0	0	4	0	12	0	0	68	0	0
Triceratium, . . .	0	0	0	0	0	0	0	0	0	0	8	0	0

SPRINGFIELD.

Microscopical Examination of Water from Ludlow Reservoir, collected near the Bottom — Concluded.

[Number of organisms per cubic centimeter

	[illegible]												
	June.	July	July.	Aug.	Aug.	Sept	Sept.	Oct.	Oct.	Nov.	Nov	Dec.	Dec.
PLANTS — Con.													
Cyanophyceæ,	400	61	20	116	122	[illegible]	428	862	332	572	508	40	4
Anabæna,	400	[illegible]	4	2	30	112	224	680	188	420	400	13	0
Clathrocystis,	0	3	2	32	6	8	12	2	4	0	0	0	0
Cœlosphærium,	0	0	14	32	86	126	192	172	140	152	100	27	4
Microcystis,	0	0	0	0	0	6	0	8	0	0	8	0	0
Algæ,	6	11	914	2,566	1,436	330	472	72	64	84	196	44	50
Chlorococcus,	0	0	0	0	0	0	0	12	0	8	12	0	0
Cœlastrum,	2	0	32	2	0	4	0	0	0	0	0	0	0
Dictyosphærium,	0	0	40	4	0	0	0	0	0	0	0	0	0
Pediastrum,	4	4	72	200	88	68	24	0	0	0	4	0	0
Protococcus,	0	0	152	900	400	32	64	12	8	28	0	8	14
Raphidium,	0	0	0	0	24	48	72	16	0	0	16	16	0
Scenedesmus,	0	7	224	1,300	900	100	120	16	20	12	96	12	36
Selenastrum,	0	0	30	0	16	0	8	0	0	0	0	0	0
Staurastrum,	0	0	364	160	6	32	40	8	0	12	36	8	0
Staurogenia,	0	0	0	0	2	66	144	8	36	24	32	0	0
Fungi, Crenothrix,	0	[illegible]	0	0	0	0	0	0	0	0	0	0	0
ANIMALS.													
Infusoria,	0	1	6	10	16	56	88	10	8	4	20	22	0
Cryptomonas,	0	0	0	0	0	0	0	0	0	0	4	2	0
Monas,	0	0	0	2	0	4	0	0	0	0	4	0	0
Peridinium,	0	0	0	0	0	0	8	0	0	0	4	4	0
Phacus,	0	0	0	2	0	0	8	0	0	0	0	0	0
Tintinnidium,	0	0	2	0	0	0	0	0	0	0	0	0	0
Trachelomonas,	0	1	4	6	16	52	72	10	8	4	8	16	0
Vermes,	0	2	0	0	4	0	0	4	4	0	0	0	0
Anuræa,	0	2	0	0	0	0	0	0	4	0	0	0	0
Rotatorian ova,	0	0	0	0	4	0	0	0	0	0	0	0	0
Rotifer,	0	0	0	0	0	0	0	4	0	0	0	0	0
Crustacea,	0	.18	.12	.04	.14	.14	.16	0	.04	.04	.08	.02	.02
Bosmina,	0	0	0	0	.14	.08	0	0	0	.02	.04	0	0
Cyclops,	0	.04	.12	0	0	.04	.08	0	0	.02	.04	.02	0
Daphnia,	0	.14	0	.04	0	.02	.08	0	.04	0	0	0	.02
Miscellaneous,	.06	5	[illegible]	160	120	120	80	20	0	100	100	80	108
Acarina,	.06	.10	0	0	0	.12	.04	0	0	0	0	0	.02
Zoöglœa,	0	5	180	160	120	120	80	20	0	100	100	80	108
TOTAL,	484	139	1,490	3,010	1,956	3,684	3,700	2,688	2,840	1,592	1,482	470	225

SPRINGFIELD.

Table showing Heights of Water in Ludlow Reservoir on the First of Each Month in 1896.

NOTE. — Height of rollway, 28.1 feet above bottom of reservoir.

Date.	Height of Water above Bottom of Reservoir	Date.	Height of Water above Bottom of Reservoir.
1896.	Feet.	1896.	Feet.
Jan. 1,	17.75	July 1,	16.50
Feb. 1,	16.84	Aug. 1,	16.20
March 1,	18.67	Sept. 1,	16.28
April 1,	18.58	Oct. 1,	18.80
May 1,	16.55	Nov. 1,	13.38
June 1,	17.32	Dec. 1,	12.85

Chemical Examination of Water from Chapin Pond, Ludlow.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
16959	July 6	Distinct, white.	Slight, white	.07	2.35	1.00	.0014	.0204	.0180	.0024	.10	.0050	.0000	-	0.2
17067	July 28	None.	V. slight	.03	2.60	1.15	.0000	.0216	.0160	.0056	11	.0030	.0000	.22	0.3
17185	Aug. 11	Slight.	Slight, earthy.	.03	2.65	1.35	.0000	.0182	.0156	.0026	.14	.0000	.0000	.23	0.3
17312	Aug 26	V. slight.	Slight.	.04	2.25	1.05	.0000	.0178	.0122	.0056	.11	[illegible]	0000	.18	0.1
17401	Sept. 8	Slight.	Slight.	.03	2.90	0.96	.0000	.0166	.0126	.0040	.13	.0030	[illegible]	.10	0.4
17534	Sept. 21	Distinct.	Slight.	.04	2.50	0.65	.0000	.0180	.0152	.0028	.12	.0020	.0000	.21	0.4
17610	Oct. 7	Slight.	Slight.	.03	2.30	0.75	.0000	.0194	.0136	.0058	.11	.0030	.0000	.16	0.5
17706	Oct. 21	Distinct.	Cons., slight.	.03	2.90	1.05	.0014	.0218	.0158	.0060	.12	.0050	.0000	.19	0.6
17817	Nov 9	Slight.	Slight.	.03	2.60	0.60	.0000	.0210	.0122	.0088	.12	.0000	.0000	.15	0.7
17945	Nov 21	Distinct.	Slight.	.03	2.55	1.05	.0004	.0248	.0150	.0098	.14	.0000	.0001	.20	0.6
18027	Dec. 8	Slight.	Slight.	.05	2.75	1.20	.0008	.0176	.0132	.0044	.13	.0000	.0000	.16	0.5
18201	Dec. 21	Distinct.	Slight.	.02	2.95	0.90	.0018	.0176	.0130	.0046	.13	.0000	.0000	.17	0.9
Av.*	....	....	....	.03	2.60	0.99	.0005	.0196	.0144	.0052	.12	.0016	.0000	.18	0.4

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, frequently none, occasionally vegetable and unpleasant. A fishy odor was observed in the last three samples. —— The samples were collected from the pond, near the surface. Water from this source was pumped into the distributing system of the Springfield water works from July 7 until Sept. 7, 1896.

SPRINGFIELD.

Microscopical Examination of Water from Chapin Pond, Ludlow.

[Number of organisms per cubic centimeter.]

	1896.											
	July.	July.	Aug.	Aug.	Sept.	Sept.	Oct.	Oct.	Nov.	Nov.	Dec.	Dec.
Day of examination,	8	30	13	28	9	23	9	23	10	24	9	26
Number of sample,	16939	17067	17185	17312	17401	17534	17610	17705	17817	17946	18027	18201
PLANTS.												
Diatomaceæ,	96	50	7	31	2	7	2	22	103	92	5	200
Asterionella,	2	0	0	0	0	0	0	16	2	8	0	0
Cyclotella,	1	0	0	0	0	0	0	0	15	0	0	200
Navicula,	0	0	1	2	0	4	2	2	4	0	0	0
Synedra,	48	2	2	10	1	3	0	4	76	76	0	0
Tabellaria,	45	48	4	19	1	0	0	0	6	8	5	0
Cyanophyceæ, Microcystis,	20	4	0	7	7	64	[illegible]	0	0	0	0	0
Algæ,	[illegible]	20	2	22	0	2	[illegible]	0	4	24	0	[illegible]
Arthrodesmus,	2	4	2	0	0	0	0	0	0	0	0	2
Chlorococcus,	0	0	0	0	0	0	0	0	4	0	0	30
Protococcus,	4	0	0	20	0	1	8	0	0	0	0	0
Raphidium,	0	16	0	1	0	1	0	0	0	0	0	5
Staurastrum,	0	0	0	1	0	0	0	0	0	8	0	0
Staurogenia,	0	0	0	0	0	0	0	0	0	16	0	0
ANIMALS.												
Infusoria,	0	2	1	6	11	0	[illegible]	10	56	252	64	610
Ciliated infusorian,	0	0	0	0	0	0	[illegible]	0	2	0	6	0
Cryptomonas,	0	0	0	0	0	0	0	0	16	0	14	0
Dinobryon,	0	0	0	0	0	0	0	0	6	0	8	604
Euglena,	0	0	0	0	0	0	0	0	0	3	0	0
Mallomonas,	0	0	0	0	0	0	0	0	0	4	0	0
Monas,	0	0	0	0	0	0	0	0	0	3	0	0
Peridinium,	0	2	1	6	11	0	0	10	16	204	32	4
Trachelomonas,	0	0	0	0	0	0	2	0	2	12	0	0
Uroglena,	0	0	0	0	0	0	0	0	6	16	4	2
Vermes,	0	[illegible]	0	1	0	0	[illegible]	4	2	12	8	[illegible]
Anuræa,	0	0	0	0	0	0	3	4	0	12	8	0
Rotifer,	0	0	0	1	0	0	0	0	2	0	0	0
Crustacea, Cyclops,	.06	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	0	0	5	20	0	10	20	0	20	60	[illegible]	66
TOTAL,	133	76	15	89	20	83	214	44	192	440	67	1,026

Chemical Examination of Water from Van Horn Reservoir, Springfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16840	June 18	Slight, white.	Slight.	.18	2.95	1.10	.0004	.0152	.0122	.0030	.11	.0000	.0000	.21	1.1
16936	July 6	Decided.	Slight, white.	.12	2.85	1.00	.0006	.0194	.0126	.0068	.18	.0070	.0000	-	0.9
17064	July 28	Slight.	V. slight.	.07	3.25	1.05	.0000	.0178	.0136	.0042	.14	.0020	.0000	.23	1.0
17183	Aug. 11	Slight.	Slight.	.04	3.35	1.25	.0002	.0148	.0120	.0028	.22	.0000	.0000	.26	1.0
17310	Aug. 26	Slight.	Slight.	.06	2.95	1.15	.0010	.0176	.0128	.0048	.16	.0000	.0000	.20	1.1
17399	Sept. 8	V. slight.	V. slight.	.06	3.65	1.35	.0000	.0166	.0134	.0032	.20	.0080	.0000	.13	1.2
17532	Sept. 21	Decided	Slight.	.15	2.85	1.00	.0012	.0154	.0128	.0026	.15	.0020	.0001	.23	1.0
17606	Oct. 7	Distinct.	Slight.	.25	3.20	0.75	.0042	.0184	.0120	.0064	.18	.0050	.0004	.20	1.1
17703	Oct. 21	Decided, milky.	Cons., yellow.	.50	4.05	1.05	.0264	.0172	.0120	.0052	.19	.0060	.0002	.16	1.7
17815	Nov. 9	Distinct.	Cons.	.35	4.05	1.35	.0100	.0156	.0132	.0024	[redacted]	.0050	.0001	.42	1.7
[redacted]	Nov. 21	Slight.	Slight.	.40	4.10	1.65	.0082	.0170	.0144	.0026	.25	.0050	.0001	.50	1.5
18025	Dec. 8	Slight.	Slight.	.36	4.00	1.40	.0086	.0178	.0134	.0044	.24	.0070	.0001	.44	1.3
18199	Dec. 21	Distinct.	Slight.	.27	3.90	1.25	.0042	.0304	.0244	.0060	.29	.0090	.0002	.38	0.9
Av.*	....	....	....	.21	3.44	1.21	.0048	.0177	.0136	.0041	.19	.0036	.0001	.27	1.2

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, generally distinctly mouldy or grassy, occasionally vegetable and unpleasant. —— The samples were collected from the reservoir, near the surface. This reservoir is a distributing reservoir of the Springfield Water Works.

Microscopical Examination of Water from Van Horn Reservoir, Springfield.

[Number of organisms per cubic centimeter.]

	1896. June.	July.	July.	Aug.	Aug.	Sept.	Sept.	Oct.	Oct.	Nov.	Nov.	Dec.	Dec.
Day of examination,	19	8	30	13	27	9	23	9	23	10	24	10	26
Number of sample,	16840	16936	17064	17183	17310	17399	17532	17606	17703	17815	17943	18025	18199
PLANTS.													
Diatomaceæ,	222	124	222	138	166	160	[redacted]	406	226	216	275	290	80
Asterionella,	165	71	30	0	0	0	432	368	138	116	4	100	30
Cyclotella,	0	11	0	0	92	80	12	14	6	6	10	4	0
Melosira,	0	0	10	0	0	0	36	0	8	30	0	92	0
Meridion,	0	0	0	0	0	0	0	0	0	0	20	0	0
Nitzchia,	0	0	0	0	0	0	0	0	0	0	0	16	44
Stephanodiscus,	4	0	60	0	0	0	0	0	0	0	0	2	0
Synedra,	0	4	38	48	0	4	6	10	0	20	220	16	2
Tabellaria,	50	38	84	90	74	76	40	64	78	44	21	60	4

SPRINGFIELD.

Microscopical Examination of Water from Van Horn Reservoir, Springfield — Concluded.

[Number of organisms per cubic centimeter.]

	1896.												
	June.	July.	July.	Aug	Aug.	Sept	Sept.	Oct.	Oct.	Nov	Nov.	Dec.	Dec.
PLANTS — Con.													
Cyanophyceæ,	44	15	20	54	0	0	8	7	1	0	0	0	0
Anabæna,	44	15	20	42	0	0	0	7	1	0	0	0	0
Clathrocystis,	0	0	0	12	0	0	0	0	0	0	0	0	0
Merismopedia,	0	0	0	0	0	0	8	0	0	0	0	0	0
Algæ,	8	46	14	32	46	6	6	10	8	6	18	46	8
Protococcus,	6	28	12	0	20	0	0	2	0	0	0	0	4
Raphidium,	0	0	0	0	0	0	5	8	8	0	2	0	4
Scenedesmus,	2	0	0	0	0	6	0	0	0	2	8	2	0
Staurogenia,	0	18	2	32	26	0	0	0	0	0	8	0	0
Zoöspores,	0	0	0	0	0	0	0	0	0	4	0	44	0
ANIMALS.													
Rhizopoda, Amœba,	2	0	0	0	0	0	0	0	0	0	0	8	0
Infusoria,	6	8	12	2	0	14	4	4	10	14	2	72	2
Ceratium,	6	5	4	0	0	0	0	2	0	0	0	0	0
Codonella,	0	0	0	0	0	0	0	0	6	8	0	0	0
Cryptomonas,	0	0	0	0	0	0	0	0	0	4	0	8	0
Dinobryon,	0	0	8	2	0	0	2	0	0	0	0	60	2
Mallomonas,	0	0	0	0	0	0	0	0	0	0	0	4	0
Monas,	0	0	0	0	0	0	0	0	0	6	2	0	0
Tintinnidium,	0	0	0	0	0	0	0	0	2	0	0	0	0
Trachelomonas,	0	0	0	0	0	14	2	2	4	2	0	0	0
Vermes,	0	0	0	0	0	0	0	0	2	4	2	0	0
Anurea,	0	0	0	0	0	0	0	0	0	0	2	0	0
Polyarthra,	0	0	0	0	0	0	0	0	0	2	0	[illegible]	0
Rotatorian ova,	0	0	0	0	0	0	0	0	2	2	0	[illegible]	0
Crustacea,	0	0	0	0	0	0	0	0	0	0	.06	0	0
Cyclops,	0	0	0	0	0	0	0	0	0	0	.04	0	0
Daphnia,	0	0	0	0	0	0	0	0	0	0	.02	0	0
***Miscellaneous,* Zoöglœa,**	10	8	20	6	20	80	60	60	240	[illegible]	60	80	60
TOTAL,	202	195	268	231	234	200	628	577	489	380	357	488	170

SPRINGFIELD.

Chemical Examination of Water from Loon Pond, Springfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid Total.	Albuminoid Dissolved	Albuminoid Sus-pended.		Nitrates.	Nitrites.		
	1896.														
16938	July 6	Distinct, white.	Slight, white.	.05	2.80	1.00	.0004	.0212	.0164	.0048	.24	.0050	.0000	–	0.6
17086	July 28	V. slight.	V. slight.	.03	2.90	1.16	.0000	.0212	.0170	.0042	.21	.0020	[illegible]	.20	1.1
17186	Aug. 11	Slight.	Slight, earthy.	.08	2.96	1.18	.0014	.0192	.0168	.0024	.25	[illegible]	.0000	.20	0.8
17313	Aug. 26	V. slight.	V. slight.	.04	2.10	1.05	.0000	.0176	.0142	.0034	.20	.0000	.0000	.18	0.9
17402	Sept. 8	Slight.	Slight, white.	.07	3.30	1.15	.0016	.0228	.0182	.0046	.24	.0000	.0000	.14	0.6
17535	Sept. 21	Slight.	Slight.	.07	2.55	1.05	.0010	.0198	.0190	.0008	.24	.0020	[illegible]	.22	0.5
17611	Oct. 7	V. slight.	V. slight.	.04	2.60	1.10	.0004	.0198	.0186	.0012	.23	.0030	.0000	.18	0.6
17706	Oct. 21	Slight.	Slight, white.	.06	3.15	1.60	.0020	.0228	.0198	.0030	.22	.0030	.0000	.30	0.9
17818	Nov. 9	V. slight.	V. slight.	.02	2.45	0.95	.0000	.0180	.0156	.0024	.24	.0000	.0000	.17	1.0
17946	Nov. 21	V. slight.	Slight.	.04	2.05	1.05	[illegible]	.0210	.0180	.0030	.24	[illegible]	.0000	.16	0.8
18028	Dec. 5	V. slight.	V. slight	.03	2.50	1.40	.0006	.0208	.0166	.0042	.22	.0030	.0000	.16	1.0
18202	Dec. 21	None.	V. slight.	.02	2.60	1.20	.0004	.0182	.0166	.0016	.24	[illegible]	.0000	.18	0.8
Av.*	....	....	....	.04	2.55	1.15	.0007	.0202	.0172	.0030	.23	.0017	.0000	.19	0.8

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, generally faintly vegetable, frequently none. —— The samples were collected from the pond, near the surface. This pond is not used as a source of public water supply.

Microscopical Examination of Water from Loon Pond, Springfield.

[Number of organisms per cubic centimeter.]

	1896.												
	June.	July.	July	Aug	Aug	Sept.	Sept.	Oct.	Oct.	Nov.	Nov	Dec.	Dec.
Day of examination,	19	8	30	13	28	9	23	9	23	10	24	10	26
Number of sample,	–	16938	17086	17186	17313	17402	17535	17611	17706	17818	17946	18028	18202
PLANTS.													
Diatomaceæ,	2	0	0	1	0	1	15	0	0	0	6	2	15
Asterionella,	0	0	0	0	0	0	0	0	0	0	0	0	9
Synedra,	0	0	0	1	0	1	15	0	0	0	5	0	2
Tabellaria,	2	0	0	0	0	0	0	0	0	0	0	2	4
Cyanophyceæ,	10	54	4	17	56	11	7	24	8	1	0	0	2
Clathrocystis,	0	6	2	0	0	0	0	0	0	0	0	0	0
Microcystis,	10	48	2	17	56	11	7	24	8	1	0	0	2
Algæ,	28	18	52	5	0	0	6	2	0	0	0	0	0
Chlorococcus,	0	0	52	0	0	0	0	2	0	0	0	0	0
Protococcus,	28	18	0	5	0	0	6	0	0	0	0	0	0

SPRINGFIELD.

Microscopical Examination of Water from Loon Pond, Springfield — Concluded.

[Number of organisms per cubic centimeter.]

	1896.												
	June.	July.	July.	Aug.	Aug	Sept.	Sept.	Oct.	Oct.	Nov.	Nov	Dec.	Dec.
ANIMALS.													
Infusoria,	0	1	2	2	25	1	8	0	0	0	2	0	0
Ceratium,	0	1	0	0	1	0	2	0	0	0	0	0	0
Peridinium,	0	0	2	2	24	1	1	0	0	0	[illegible]	0	0
Trachelomonas,	0	0	0	0	0	0	5	0	0	0	[illegible]	0	0
Crustacea, Cyclops,	0	.04	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous,	.02	10	10	20	20	10	20	5	0	[illegible]	5	0	0
Acarina,	.02	0	0	0	0	0	0	0	0	0	0	0	0
Zoöglœa,	0	10	10	20	20	10	20	5	0	5	5	0	0
TOTAL,	[illegible]	33	68	46	101	23	54	31	8	6	16	2	17

Chemical Examination of Water from Five Mile Pond, Springfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
16841	[illegible] June 18	V. slight.	V. slight.	.10	2.15	1.05	.0000	.0212	[illegible]	.0022	.10	.0000	.0000	.25	0.6
16937	July 6	Distinct.	V. slight.	.10	2.05	1.00	.0010	.0220	.0206	.0014	.14	.0000	.0000	–	0.4
17085	July 28	V. slight.	V. slight.	.07	2.50	1.30	.0008	.0228	.0184	.0044	.13	.0020	.0000	.27	0.6
17194	Aug. 11	V. slight.	V. slight.	.05	2.60	1.25	.0000	.0216	.0196	.0020	.16	.0000	.0000	.27	0.3
17311	Aug. 26	V. slight.	V. slight.	.07	2.00	1.10	.0000	.0208	.0186	.0022	.13	.0000	.0000	.25	0.3
17400	Sept. 8	V. slight.	V. slight.	.07	2.85	1.70	.0009	.0206	.0166	.0040	.17	.0030	.0000	.30	0.3
17533	Sept. 21	Distinct.	Slight.	.08	1.80	0.35	.0014	.0194	.0180	.0014	.16	.0020	.0000	.24	0.6
17609	Oct. 7	V. slight.	V. slight.	.08	2.05	0.80	.0002	.0230	.0204	.0026	.15	.0080	.0000	.14	0.3
17704	Oct. 21	Distinct.	Slight.	.05	2.30	0.95	.0052	.0214	.0192	.0022	.16	.0030	.0000	.21	0.5
17816	Nov. 9	V. slight.	V. slight.	.05	2.[illegible]	0.65	.0006	.0222	.0210	.0012	.19	.0000	.0000	.16	0.5
17944	Nov. 21	V. slight.	None.	.07	2.25	0.90	.0012	.0218	.0198	.0020	.15	.0000	.0000	.13	0.3
18026	Dec. 8	Slight.	Slight, earthy.	.18	2.[illegible]	1.00	.0010	.0208	.0198	.0010	.13	.0000	.0000	[illegible]	0.5
18200	Dec. 21	None.	Slight.	.05	2.30	1.05	.0050	.0202	.0198	.0004	.19	.0000	.0000	.22	0.5
Av.*	....	....	....	[illegible]	2.28	1.06	.0009	.0214	.0193	.0021	.15	.0009	.0000	.22	0.4

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, generally none, occasionally vegetable. On heating, the odor became faintly vegetable or *earthy.* — The samples were collected from the pond, near the surface. This pond is not used as a *source of public water supply.*

SPRINGFIELD.

Microscopical Examination of Water from Five Mile Pond, Springfield.

[Number of organisms per cubic centimeter.]

	1896.												
	June.	July	July	Aug	Aug.	Sept.	Sept.	Oct.	Oct.	Nov.	Nov.	Dec.	Dec.
Day of examination,	19	8	30	13	27	9	23	9	23	10	24	10	26
Number of sample,	16841	16937	17085	17184	17311	17400	17533	17609	17704	17816	17944	18026	18200
PLANTS.													
Diatomaceæ,	0	0	0	0	1	0	2	1	0	1	20	18	[illegible]
Asterionella,	0	0	0	0	0	0	0	0	0	0	16	0	6
Navicula,	0	0	0	0	1	0	0	1	0	0	0	8	0
Synedra,	0	0	0	0	0	0	2	0	0	1	4	10	4
Cyanophyceæ,	12	2	11	3	40	42	47	20	0	1	0	0	0
Anabæna,	12	0	0	0	0	2	0	2	0	1	0	0	0
Clathrocystis,	0	2	6	0	0	0	0	0	0	0	0	0	0
Merismopedia,	0	0	0	0	0	0	9	0	0	0	0	0	0
Microcystis,	0	0	5	3	40	40	38	18	0	0	0	0	0
Algæ,	1	0	5	0	0	1	13	2	2	4	26	12	0
Protococcus,	1	0	5	0	0	1	3	2	2	0	16	0	0
Raphidium,	0	0	0	0	0	0	8	0	0	4	0	12	0
Staurogenia,	0	0	0	0	0	0	2	0	0	0	10	0	0
ANIMALS.													
Rhizopoda, Actinophrys,	0	0	0	[illegible]	0	0	0	0	0	1	2	0	0
Infusoria,	9	0	0	0	0	1	13	[illegible]	13	5	0	34	2
Dinobryon,	0	0	0	0	0	1	13	0	3	0	0	32	2
Mallomonas,	9	0	0	0	0	0	0	1	0	2	0	0	0
Synura,	0	0	0	0	0	0	0	3	10	3	0	0	0
Trachelomonas,	0	0	0	0	0	0	0	0	0	0	0	2	0
Crustacea, Cyclops,	.02	.06	0	0	0	.02	.02	[illegible]	0	0	0	0	[illegible]
Miscellaneous, Zoöglœa,	0	0	5	5	5	10	10	5	0	5	0	40	15
TOTAL,	22	2	21	13	46	54	135	32	15	17	50	104	29

WATER SUPPLY OF STOCKBRIDGE. — STOCKBRIDGE WATER COMPANY.

The water of Lake Averic was affected in the months of November and December by the presence of the organism *Uroglena*, which imparted a disagreeable taste and odor to the water.

STOCKBRIDGE.

Chemical Examination of Water from Lake Averic, Stockbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16144	Feb. 25	Slight.	Slight.	.18	7.40	1.30	.0014	.0176	.0160	.0016	.06	.0060	.0001	.27	5.3
16491	Apr. 28	Distinct, green	Slight.	.12	5.30	1.25	.0002	.0166	.0136	.0030	.05	.0050	.0001	.23	3.9
16884	June 24	Distinct.	Slight, green.	.15	6.10	1.35	.0002	.0212	.0150	.0062	.06	.0020	.0001	.31	4.4
17733	Oct. 27	Distinct.	Slight.	.13	6.45	1.50	.0006	.0216	.0196	.0020	.09	.0030	.0000	.31	5.3
18208	Dec. 28	Distinct	Slight.	.12	7.06	1.75	.0006	.0208	.0156	.0052	.11	.0080	.0000	.32	5.3

Averages by Years.

-	1893	-	-	.06	6.15	1.46	.0092	.0155	.0127	.0028	.07	.0067	.0020	.26	4.1
-	1894*	-	-	.13	6.72	1.60	.0007	.0200	.0175	.0025	.08	.0015	.0000	.31	4.4
-	1895†	-	-	.18	5.95	1.35	.0007	.0213	.0168	.0045	.06	.0060	.0000	.25	4.4
-	1896	-	-	.14	6.46	1.43	.0006	.0196	.0160	.0036	.09	.0036	.0001	.29	4.8

* August and October. † May and November.

NOTE to analyses of 1896: Odor of the first sample, none, becoming faintly earthy on heating; of the second, fishy; of the third, distinctly vegetable and unpleasant; of the fourth, none, becoming distinctly fishy on heating; of the last, distinctly fishy and oily. —— The first sample was collected from a faucet at the pumping station, and the others from the lake.

Microscopical Examination of Water from Lake Averic, Stockbridge.

[Number of organisms per cubic centimeter.]

	1896. Feb.	1896. Apr.	1896. June.	1896. Oct.	1896. Nov.	1896. Nov.	1896. Dec.
Day of examination,	26	29	25	28	7	7	30
Number of sample,	16144	16491	16884	17733	-	-	18208
PLANTS.							
Diatomaceæ,	6	30	8	87	97	144	[illegible]
Asterionella,	4	18	0	80	88	144	3
Fragilaria,	0	5	7	5	0	0	0
Navicula,	0	4	0	0	1	0	0
Synedra,	2	3	1	2	8	0	1
Cyanophyceæ, Clathrocystis,	0	0	6	0	0	0	0
Algæ, Protococcus,	0	0	11	5	0	0	0

STOCKBRIDGE.

Microscopical Examination of Water from Lake Averic, Stockbridge — Concluded.

[Number of organisms per cubic centimeter.]

	1896.						
	Feb.	Apr.	June.	Oct.	Nov.	Nov.	Dec.
ANIMALS.							
Infusoria,	**1**	**13**	**106**	**3**	**15**	**11**	**25**
Ceratium,	0	0	1	0	0	0	0
Dinobryon,	0	11	0	0	0	0	0
Monas,	0	0	2	0	0	0	0
Peridinium,	1	1	100	0	0	0	0
Synura,	0	1	0	0	0	0	0
Trachelomonas,	0	0	2	2	2	1	0
Uroglena,	0	0	1	1	12	10	25
Vorticella,	0	0	0	0	1	0	0
Vermes,	**1**	**1**	**10**	**0**	**0**	**1**	**0**
Anuræa,	1	1	9	0	0	1	0
Polyarthra,	0	0	0	0	0	1	0
Rotifer,	0	0	1	0	0	0	0
Crustacea,	**.02**	**0**	**0**	**.02**	**0**	**0**	**0**
Bosmina,	0	0	0	.02	0	0	0
Cyclops,	.02	0	0	0	0	0	0
Miscellaneous,	**.04**	**40**	**20**	**0**	**.02**	**0**	**0**
Acarina,	.04	.04	.02	0	.02	0	0
Zoöglœa,	0	40	20	0	0	0	0
TOTAL,	8	84	164	95	112	156	29

WATER SUPPLY OF STONEHAM.

(See *Wakefield*.)

WATER SUPPLY OF SWAMPSCOTT AND NAHANT. — MARBLEHEAD WATER COMPANY.

The water supplied to Swampscott and Nahant during 1896 was drawn from three sources, viz.: a large well and a group of 72 tubular wells in the valley of Stacy's Brook, not far from the sea-shore; a system of tubular wells in Paradise Road; and a system of tubular wells a short distance east of the Swampscott station on the eastern division of the Boston & Maine Railroad. The wells in the valley of Stacy's Brook are located in densely populated territory, and are probably affected by the presence of a small amount of sea-water.

SWAMPSCOTT AND NAHANT.

The advice of the State Board of Health to the Marblehead Water Company relative to taking an additional water supply from the ground in the neighborhood of Thompson's Meadow in Salem may be found on pages 40 to 42 of this volume.

Chemical Examination of Water from the Wells of the Marblehead Water Company, Swampscott.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15852	Jan. 7	Decided, clayey	Cons., earthy.	.08	11.30	.0012	.0036	1.37	.0400	.0000	.09	4.6	.0120
16003	Feb. 4	Distinct, clayey.	Slight, earthy.	.08	13.30	.0000	.0040	1.72	.0750	.0000	.11	6.1	.0060
16032	Feb. 11	Slight, milky.	Slight.	.03	61.30	.0006	.0032	19.70	.1500	.0000	.10	14.0	.0070
16188	Mar. 3	Slight, milky.	V. slight.	[illegible]	14.90	.0014	.0016	1.82	.0920	.0000	.04	6.9	.0020
16389	Apr. 9	None.	Slight, earthy.	[illegible]	32.00	.0000	.0080	7.89	.2000	.0000	.13	9.0	.0060
16544	May 8	None.	None.	.00	41.70	.0008	.0042	12.04	.1100	.0000	.06	18.2	.0050
16780	June 12	None.	None.	.03	93.60	.0000	.0012	32.68	.1060	.0000	.09	40.0	.0060
16924	July 6	None.	None.	.01	109.50	.0000	.0012	37.80	.2250	.0000	.07	42.8	.0030
17126	Aug. 6	None.	None.	.02	–	.0002	.0014	2.10	.0500	.0001	.08	10.5	.0020
17322	Aug. 28	None.	V. slight.	.01	80.20	.0000	.0068	12.16	.3250	.0000	.08	17.0	.0010
17326	Aug. 28	None.	None.	.02	106.90	.0004	.0006	37.68	.1050	.0000	.06	49.0	.0010
17360	Sept. 2	None.	None.	.03	125.40	.0022	.0014	46.08	.3600	.0010	.10	56.5	.0000
17615	Oct. 7	None.	V. slight.	.00	134.20	.0002	.0028	50.98	.0600	.0004	.09	54.5	.0100
17783	Nov. 3	None.	None.	.00	15.80	.0006	.0018	2.04	.0400	.0000	.00	8.3	.0040
18000	Dec. 4	None.	None.	.00	11.80	.0004	.0006	1.90	.0350	[illegible]	.01	–	.0010

Averages by Years.

–	1887*	–	–	.03	23.88	.0032	.0028	2.94	.5302	–	–	–	–
–	1888	–	–	.00	25.16	.0007	.0035	3.26	.4477	.0003	–	–	–
–	1889†	–	–	.00	26.20	.0006	.0033	8.80	.4390	.0002	–	–	–
–	1890‡	–	–	.00	44.00	.0008	.0010	8.80	.6250	.0001	–	21.2	–
–	1891	–	–	.00	28.64	.0018	.0010	7.73	.9909	.0002	–	18.0	–
–	1892	–	–	.00	54.94	.0000	.0010	14.53	.7437	.0000	–	22.0	.0074
–	1893	–	–	.01	46.42	.0000	.0022	12.12	.4263	.0000	.07	14.7	.0061
–	1894	–	–	.04	37.84	.0002	.0015	10.52	.2983	.0000	.05	15.8	.0066
–	1895	–	–	.08	29.51	.0002	.0033	6.91	.1148	.0000	.10	9.4	.0072
–	1896§	–	–	.02	58.86	.0006	.0028	18.53	.1275	.0001	.07	25.2	.0047

* June to December. † January to May. ‡ October.

§ Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1896: Odor of Nos. 16003 and 16188, faintly earthy; of the others, none. —— Nos. 16389, 16544 and 17322 were collected from the large well near the pumping station; Nos. 15852, 16003, 16188, 16780 and 16924, from a faucet at the pumping station; the others, from faucets in the town.

Microscopical Examination.

An insignificant number of organisms was found in sample No. 15852; no organisms were found in the remaining samples.

SWAMPSCOTT AND NAHANT.

Chemical Examination of Water from a System of Tubular Wells in the Valley of Stacy's Brook, and from a System of Tubular Wells in Paradise Road, Swampscott.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
17324	Aug 28	None.	None.	.02	189.70	.0042	.0014	40.20	.1100	.0020	.11	62.0	.0030
17325	Aug. 28	None.	None.	.00	17.40	.0002	.0002	2.24	.0900	.0000	.01	10.0	.0040

Odor, none. —— The first sample was collected from a pump drawing water from 72 tubular wells in the valley of Stacy's Brook, near the pumping station of the Marblehead Water Company in Swampscott; the second, from a pump drawing water from tubular wells in Paradise Road.

Microscopical Examination.

No organisms.

Chemical Examination of Water from a System of Tubular Wells a Short Distance East of the Swampscott Station on the Boston & Maine Railroad.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
16245	Mar. 11	Decided, clayey	Slight.	.04	11.40	[illegible]	.0010	1.46	.0180	.0000	.06	6.3	.0030
16720	June 2	None.	V slight.	.02	13.10	.0000	.0022	1.82	.0500	.0021	.01	7.7	.0020
17323	Aug. 28	None.	None.	.00	15.60	.0010	.0004	1.87	.0450	.0007	.01	8.5	[illegible]
Av.	....	....	....	.02	13.37	.0003	.0012	1.72	.0377	.0009	.02	7.5	.0017

Odor, none.—— A distinctly earthy odor was developed in the first sample on heating.

Microscopical Examination.

No organisms.

SWAMPSCOTT AND NAHANT.

Chemical Examination of Water from Test Wells at the Southerly End of Thompson's Meadow in Swampscott and Salem.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
17104	Aug. 1	None.	V. slight.	.08	10.40	[illegible]	.0016	1.40	.0900	.0000	.04	3.7	.0020
17105	Aug. 1	None.	Slight.	.02	10.40	.0002	.0014	1.02	.0050	.0000	.03	5.1	.0020
17106	Aug. 1	Slight, clayey.	Heavy, sandy	.05	10.80	.0000	.0000	1.01	.0000	.0000	.03	6.2	.0080
17107	Aug. 1	Distinct, clayey.	Cons., sandy.	.07	10.20	.0000	.0004	1.18	.0050	.0000	.04	4.9	.0140
17581	Oct. 3	None.	V. slight.	.03	9.00	.0012	.0016	1.12	.0030	[illegible]	.06	3.9	.0150
17580	Oct. 4	None.	V. slight.	.02	9.20	.0002	.0010	1.11	.0050	.0000	.06	4.2	.0060
17616	Oct. 7	None.	V. slight.	.01	9.30	.0002	.0015	1.06	.0120	.0000	.02	4.3	.0070
17621	Oct. 10	None.	V. slight.	.00	9.90	.0006	.0020	1.05	.0120	.0000	.04	4.9	.0080
17655	Oct. 15	V. slight.	Slight, earthy.	.00	10.50	.0002	.0006	1.03	.0070	.0000	.03	4.6	.0100

Odor of the last sample, faintly earthy, disappearing on heating; of the others, none. —— The samples were collected as follows: No. 17104, from a spring near the roadside at southerly end of Thompson's Meadow; No. 17105, from a spring in Thompson's Meadow, about 400 feet north of Peabody Road and 300 feet west of railroad; No. 17106, from a tubular well about 25 feet from the latter spring; No. 17107, from a tubular well about 400 feet north of the Peabody Road and 125 feet from the railroad; the last five samples, from the pump drawing water from a group of 6 tubular wells at the southerly end of Thompson's Meadow, during a pumping test of twelve days' duration. The first sample (17581) was collected on October 3, about an hour after pumping began, and the last sample was collected on the last day of the test.

Microscopical Examination.

An insignificant number of organisms was found in samples Nos. 17104, 17105 and 17107; no organisms were found in the remaining samples.

Chemical Examination of Water from a Pond in Swampscott.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16243	Mar. 11	None.	V. slight.	.50	3.50	1.60	.0000	.0120	-	-	.56	.0020	.0000	.55	1.4

Odor, distinctly vegetable and mouldy. —— The sample was collected from the outlet of a small pond on a brook in the north-westerly part of Swampscott.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

Water Supply of Taunton.

Chemical Examination of Water from Assawompsett Pond, Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15980	Jan. 27	Slight.	Slight.	.32	3.45	1.75	.0010	.0156	.0140	.0016	.53	.0020	.0000	.55	0.9
16142	Feb. 24	Slight.	Slight.	.38	3.75	1.15	.0002	.0192	.0182	[illegible]	.51	.0000	.0000	.53	1.6
16304	Mar. 23	Distinct, green.	Slight.	.40	2.95	1.40	.0006	.0186	.0156	.0030	.49	.0050	.0000	.58	1.0
16457	Apr. 27	Slight.	Slight.	.40	3.55	1.20	.0008	.0174	.0158	.0016	.50	.0050	.0000	.62	1.0
16675	May 25	Slight.	Slight.	.40	4.10	1.60	.0008	.0166	.0144	.0022	.48	.0060	.0000	.58	1.0
16885	June 22	Slight.	Cons.	.38	4.85	2.60	.0022	.0172	.0162	[illegible]	.53	[illegible]	.0000	.56	0.9
17071	July 27	Slight.	Slight.	.35	3.75	1.30	.0022	.0204	.0170	.0034	.54	.0050	.0000	.48	[illegible]
17280	Aug. 24	V. slight.	Slight.	.30	3.25	1.15	.0004	.0176	.0166	.0010	.56	.0000	.0001	.42	0.6
17509	Sept 28	Slight.	Slight.	.30	3.50	1.35	.0004	.0152	.0162	.0020	.55	.0050	.0000	.56	1.0
17725	Oct. 26	V. slight.	V. slight.	.18	3.15	1.20	.0008	.0194	.0182	.0012	.61	.0050	.0000	.40	0.6
17960	Nov. 24	Slight.	V. slight.	.22	3.25	1.30	.0002	.0156	.0138	.0018	.61	.0000	[illegible]	.43	[illegible]
18173	Dec. 21	Slight.	Slight.	.30	3.45	1.60	.0006	.0196	.0162	.0034	.61	.0000	.0001	.51	1.3

Averages by Years.

-	1887*	-	-	.45	3.63	1.57	.0005	.0180	-	-	.48	.0016	-	-	-
-	1888†	-	-	.30	4.20	1.35	.0001	.0238	-	-	.45	.0030	.0001	-	-
-	1891‡	-	-	.08	2.60	1.02	.0000	.0157	.0110	.0047	.46	.0025	.0000	-	0.4
-	1894	-	-	.33	3.22	1.26	.0009	.0157	.0132	.0026	.51	.0021	.0000	.45	0.7
-	1895	-	-	.36	3.34	1.64	.0005	.0185	.0157	.0028	.53	.0018	.0000	.50	0.7
-	1896	-	-	.33	3.58	1.47	[illegible]	.0179	[illegible]	.0019	.54	.0032	.0000	.52	0.9

* June and September. † January and May. ‡ December, two samples.

Note to analyses of 1896 Odor, generally vegetable, frequently none. —— The samples were collected from the pond, at the intake of the Taunton Water Works.

TAUNTON.

Microscopical Examination of Water from Assawompsett Pond, Lakeville.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	28	26	25	0	27	23	30	26	29	28	27	23
Number of sample,	15960	16142	16304	16457	16675	16856	17071	17280	17559	17726	17960	18172
PLANTS.												
Diatomaceæ,	11	86	210	35	27	18	13	11	17	[illegible]	90	74
Asterionella,	0	44	41	17	6	8	0	0	0	34	24	58
Cyclotella,	1	3	1	1	13	0	0	0	0	6	2	0
Diatoma,	0	0	63	0	0	0	0	0	2	0	0	0
Fragilaria,	0	0	16	0	0	0	1	0	0	0	0	4
Melosira,	0	10	35	15	8	8	10	11	12	54	54	0
Synedra,	6	11	23	2	0	0	1	0	3	16	4	12
Tabellaria,	4	16	31	0	0	0	[illegible]	0	0	0	6	0
Cyanophyceæ,	0	0	0	0	24	1	0	0	0	0	0	0
Merismopedia,	0	0	0	0	14	0	0	0	0	0	0	0
Microcystis,	0	0	0	0	10	1	0	0	0	0	0	0
Algæ, Protococcus,	3	0	14	7	0	27	0	3	0	[illegible]	0	0
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	0	0	1	[illegible]	1	0	0	0	0
Infusoria,	5	36	770	2	0	33	1	11	3	0	0	0
Dinobryon,	5	36	760	2	0	29	0	1	2	0	0	0
Mallomonas,	0	0	0	0	0	2	0	0	0	0	0	0
Monas,	0	0	1	0	0	0	0	2	0	0	0	0
Peridinium,	0	3	8	0	0	2	0	6	1	0	0	0
Trachelomonas,	0	0	1	0	0	0	1	2	0	0	0	0
Vermes, Rotatorian ova,	0	2	0	4	0	0	0	0	1	0	0	0
Crustacea, Cyclops,	0	[illegible]	0	0	0	.08	0	0	.02	0	0	0
Miscellaneous,	0	20	20	0	0	4	10	30	10	0	[illegible]	50
Acarina,	0	0	.02	0	0	.02	0	0	0	0	0	0
Zoöglœa,	0	20	20	0	0	4	10	30	10	0	0	50
TOTAL,	19	195	1,014	44	51	82	24	56	31	110	90	124

TAUNTON.

Chemical Examination of Water from Elder's Pond, Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15961	Jan. 27	Slight.	None.	.08	2.85	0.85	.0022	.0122	.0110	.0012	.48	.0000	.0000	.21	0.5
16142	Feb. 24	Slight.	Slight.	.07	2.90	0.95	.0008	.0184	.0144	.0040	.49	.0000	.0000	.22	0.3
16305	Mar. 23	Slight.	Slight.	.07	2.15	0.85	.0006	.0232	.0138	.0094	.49	.0000	.0000	.25	0.5
16486	Apr. 27	V. slight.	Slight.	.07	2.75	0.95	.0006	.0168	.0152	.0016	.48	.0050	.0001	.20	0.7
16674	May 25	Slight.	Slight.	.06	2.95	0.90	.0002	.0146	.0132	.0014	.49	.0040	.0000	.21	0.6
16854	June 22	None.	V. slight.	.04	2.60	1.05	.0004	.0148	.0116	.0028	.50	.0000	.0000	.21	0.7
17070	July 27	Slight.	Slight.	.10	3.15	1.15	.0000	.0192	.0160	.0032	.48	.0030	.0000	.24	0.8
17281	Aug. 24	V. slight.	Slight.	.08	2.50	0.95	.0000	.0176	.0136	.0040	.41	.0000	.0000	.23	0.4
17568	Sept. 28	Slight.	Slight.	.08	2.95	0.95	.0009	.0158	.0132	.0026	.49	.0030	.0000	.30	0.4
17725	Oct. 26	V. slight.	V. slight.	.08	2.80	0.85	.0002	.0172	.0160	.0012	.52	.0020	.0000	.19	0.6
17959	Nov. 24	Slight.	V. slight.	.06	2.90	0.95	.0006	.0166	.0152	.0014	.53	.0020	.0000	.21	0.4
18174	Dec. 21	None.	V. slight.	.08	2.55	1.10	.0006	.0162	.0130	.0032	.54	.0000	.0000	.12	0.3

Averages by Years.

-	1887*	-	-	.00	2.50	0.55	.0004	.0130	-	-	.41	.0080	-	-	-
-	1888†	-	-	.06	3.00	0.45	.0000	.0138	-	-	.35	.0000	.0000	-	-
-	1891‡	-	-	.00	2.08	0.90	.0000	.0143	.0120	.0023	.40	.0010	.0001	-	0.3
-	[illegible]	-	-	.04	2.32	0.94	.0004	.0135	.0120	.0015	.42	.0015	.0000	.17	0.4
-	1895	-	-	.05	2.57	0.98	.0001	.0161	.0143	.0018	.46	.0018	.0000	.22	0.5
-	1896	-	-	.05	2.70	0.96	.0005	.0169	.0139	.0030	.50	.0017	.0000	.22	0.5

* September. † May. ‡ December, two samples.

NOTE to analyses of 1896. Odor, generally faintly vegetable or mouldy, sometimes none. The odor generally became stronger on heating. —— The samples were collected from the pond, near the gate-house of the Taunton Water Works.

TAUNTON.

Microscopical Examination of Water from Elder's Pond, Lakeville.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	28	26	25	30	27	22	30	26	29	28	27	22
Number of sample,	15961	16145	16306	[illegible]	16674	16854	17070	17251	17559	17726	17909	18174
PLANTS.												
Diatomaceæ,	0	7	[illegible]	[illegible]	2	1	10	0	21	12	52	44
Asterionella,	0	6	5	0	0	0	8	0	18	5	42	28
Cyclotella,	0	0	3	0	0	0	0	0	0	0	0	16
Melosira,	0	0	0	0	0	0	0	0	0	0	10	0
Navicula,	0	0	0	0	2	0	0	0	2	3	0	0
Synedra,	0	1	2	6	1	1	2	0	1	4	0	2
Cyanophyceæ,	0	0	0	0	0	48	34	37	255	7	[illegible]	0
Anabæna,	0	0	0	0	0	40	0	0	0	7	0	0
Merismopedia,	0	0	0	0	0	0	14	11	11	0	0	0
Microcystis,	0	0	0	0	0	8	20	26	244	0	18	0
Algæ,	0	0	0	0	0	43	0	[illegible]	0	15	0	16
Cœlastrum,	0	0	0	0	0	17	0	0	0	0	0	0
Protococcus,	0	0	0	0	0	13	0	6	[illegible]	4	0	0
Raphidium,	0	0	0	0	0	13	0	1	0	4	0	16
Staurogenia,	0	0	0	0	0	0	0	0	0	7	0	0
ANIMALS.												
Infusoria,	72	31	77	0	0	7	[illegible]	40	[illegible]	2	48	8
Dinobryon,	72	31	77	0	0	0	0	0	22	2	48	8
Mallomonas,	0	0	0	0	0	0	0	0	7	0	0	0
Monas,	0	0	0	0	0	0	0	0	2	0	0	0
Peridinium,	0	0	0	0	0	7	32	40	0	0	0	0
Vermes, Rotifer,	0	[illegible]	0	0	2	[illegible]	[illegible]	0	1	[illegible]	0	0
Crustacea, Cyclops,	0	[illegible]	.02	0	0	0	0	0	0	0	0	0
Miscellaneous,	0	0	5	0	0	0	0	10	[illegible]	5	0	20
Acarina,	0	0	.04	0	0	0	0	0	0	0	0	0
Zoöglœa,	0	0	5	0	0	0	0	10	25	5	0	20
TOTAL,	72	38	88	6	5	99	76	96	334	41	116	88

TAUNTON.

Chemical Examination of Water from the Filter-basin of the Taunton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16452	Apr. 27	Slight.	Slight.	.25	4.75	1.35	.0000	.0170	.0120	.0050	.62	.0350	.0005	.23	1.6
16676	May 25	Distinct, white.	Slight, white.	.02	5.25	1.46	.0024	.0124	.0090	.0034	.67	.0400	.0006	.09	1.7
17282	Aug. 24	Distinct.	Slight, green.	.03	5.15	1.56	.0000	.0182	.0108	.0074	.66	.0400	.0010	.11	1.6
18175	Dec. 21	Decided.	Slight.	.02	4.20	1.40	.0006	.0134	.0078	.0056	.79	.0450	.0001	.10	1.6

Averages by Years.

–	1887*	–	–	.29	5.66	–	.0017	.0098	–	–	[illegible]	.0167	–	–	–
–	1888	–	–	.47	5.40	–	.0010	.0129	–	–	.55	.0150	.0001	–	–
–	1889	–	–	.29	5.12	–	.0012	.0078	–	–	.57	.0185	.0001	–	–
–	1890	–	–	.33	5.91	–	.0012	.0087	–	–	.57	.0227	.0001	–	1.9
–	1891	–	–	.35	5.25	1.49	.0014	.0073	–	–	.66	.0212	.0000	–	1.7
–	1892	–	–	.60	5.53	1.65	.0006	.0124	–	–	.56	.0147	.0001	–	1.5
–	1893	–	–	.62	5.41	1.32	.0026	.0149	–	–	.57	.0114	.0001	65	1.4
–	1894	–	–	.26	4.36	1.16	.0008	.0182	.0096	.0087	.55	.0175	.0001	.29	1.2
–	1895	–	–	.07	4.06	1.28	.0011	.0141	.0086	.0055	.57	.0254	.0003	.15	1.4
–	1896	–	–	.06	4.64	1.44	.0007	.0152	[illegible]	.0055	.66	.0400	.0005	.12	1.6

* June to December.

Note to analyses of 1896: Odor of the first sample, faintly mouldy, becoming distinctly vegetable and grassy on heating; of the second, unpleasant; of the third, none; of the last, faintly fishy and oily, becoming stronger on heating. —— The samples were collected from the filter-basin. Water from this source was used during the year 1896 for only two days in the month of April.

TAUNTON.

Microscopical Examination of Water from the Filter-basin of the Taunton Water Works.

[Number of organisms per cubic centimeter.]

	1896.			
	April.	May.	August.	December.
Day of examination,	30	27	26	23
Number of sample,	16488	16676	17282	18175
PLANTS.				
Diatomaceæ,	2,020	84	300	96
Asterionella,	1,320	37	0	28
Fragilaria,	0	2	20	0
Melosira,	0	0	10	2
Navicula,	0	1	2	0
Synedra,	700	44	268	66
Cyanophyceæ,	0	5	0	0
Anabæna,	0	3	0	0
Merismopedia,	0	2	0	0
Algæ,	0	14	4	10
Eudorina,	0	6	0	2
Protococcus,	0	0	4	8
Raphidium,	0	8	0	0
Fungi, Molds,	0	0	8	0
ANIMALS.				
Infusoria,	7	305	12	12
Dinobryon,	0	104	0	0
Peridinium,	7	200	12	12
Trachelomonas,	0	1	0	0
Vermes,	0	0	8	0
Anuræa,	0	0	6	0
Polyarthra,	0	0	2	0
Miscellaneous, Zoöglœa,	0	0	20	0
TOTAL,	2,027	408	352	120

Water Supply of Tisbury. — Vineyard Haven Water Company.

Chemical Examination of Water from the Filter-gallery at Tashmoo Spring.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	[illegible]	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
17091	1896. July 29	None.	V. slight.	.00	3.90	.0000	.0000	.98	.0070	.0000	.02	[illegible]	.0000

Odor, faintly earthy, becoming distinctly vegetable on heating. —— The sample was collected from a faucet at the pumping station, while pumping.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

Water Supply of Uxbridge.

The advice of the State Board of Health to the town of Uxbridge relative to the quality of the water in the well in Capron's Mill Yard, which has been used as an auxiliary source of public water supply for the town, may be found on pages 42 and 43 of this volume. An analysis of a sample of water collected from the well is given below.

Chemical Examination of Water from a Well in the Yard of Capron's Mill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
16774	1896. June 11	None.	V. slight.	.01	10.40	.0000	.0050	.44	.5500	.0000	.09	4.2	.0020

Odor, very faint or none.

Microscopical Examination.

Miscellaneous, *Zoöglœa*, 30.

WAKEFIELD AND STONEHAM.

WATER SUPPLY OF WAKEFIELD AND STONEHAM. — WAKEFIELD WATER COMPANY.

Chemical Examination of Water from Crystal Lake, Wakefield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16224	Mar. 10	Distinct.	Slight.	.30	4.45	1.35	.0006	.0162	.0148	.0014	.65	.0200	.0001	.33	2.0
16746	June 6	V. slight.	V. slight.	.20	[illegible]	1.45	.0022	.0160	.0142	.0018	.70	.0170	.0001	.26	2.1
17450	Sept. 14	Slight.	Slight, green.	.23	4.70	1.45	.0024	.0224	.0174	.0050	.71	.0000	.0000	.27	1.9
18112	Dec. 14	Slight.	Slight.	.10	4.30	1.10	.0030	.0154	.0130	.0024	.74	.0150	.0000	.24	2.1

Averages by Years.

-	1887*	-	-	.17	3.75	0.91	.0006	.0174	-	-	.51	.0043	-	-	-
-	1888†	-	-	.13	3.69	0.92	.0009	.0167	-	-	.43	.0060	.0001	-	-
-	1889‡	-	-	.10	3.60	0.87	.0009	.0141	.0119	.0022	.49	.0163	.0002	-	-
-	1890§	-	-	.25	4.22	[illegible]	.0001	.0271	.0190	.0181	.46	.0090	.0001	-	1.8
-	1891‖	-	-	.08	4.17	1.50	.0003	.0160	.0129	.0031	.47	.0145	.0001	-	[illegible]
-	1893	-	-	.14	3.51	1.27	.0028	.0164	.0141	.0023	.57	.0106	.0001	.28	1.5
-	1894	-	-	.16	4.39	1.56	.0011	.0155	.0136	.0019	.67	.0106	.0001	.24	1.8
-	1895	-	-	.18	4.46	1.50	.0023	.0166	[illegible]	.0026	.71	.0087	.0000	.32	1.7
-	1896	-	-	.19	4.56	1.34	.0021	.0175	.0148	.0027	.71	.0130	.0000	.26	2.0

* June to December. † January to October. ‡ January, March and June.
§ Three in October. ‖ May and November.

NOTE to analyses of 1896: Odor in March and December, distinctly vegetable and mouldy; at other times, faintly vegetable, becoming stronger on heating. —— The samples were collected from a faucet at the pumping station.

WAKEFIELD AND STONEHAM.

Microscopical Examination of Water from Crystal Lake, Wakefield.

[Number of organisms per cubic centimeter.]

	1896.			
	Mar.	June.	Sept.	Dec.
Day of examination,	11	11	15	15
Number of sample,	16224	16746	17450	18112
PLANTS.				
Diatomaceæ,	472	36	80	6
Asterionella,	468	0	19	0
Cyclotella,	0	0	5	0
Melosira,	0	0	40	0
Navicula,	0	0	2	0
Stephanodiscus,	1	36	0	3
Synedra,	0	0	14	2
Tabellaria,	3	0	0	1
Cyanophyceæ,	0	1	29	2
Anabæna,	0	0	7	0
Cœlosphærium,	0	0	3	0
Microcystis,	0	1	19	2
Algæ,	25	2	7	0
Cosmarium,	0	0	2	0
Pandorina,	0	0	2	0
Protococcus,	25	2	0	0
Spirogyra,	0	0	3	0
ANIMALS.				
Infusoria,	66	0	54	2
Dinobryon,	64	0	41	0
Mallomonas,	1	0	2	0
Peridinium,	0	0	0	1
Trachelomonas,	1	0	11	1
Crustacea, Bosmina,	.02	0	0	0
Miscellaneous, Zoöglœa,	0	0	30	0
TOTAL,	563	39	200	10

WALPOLE.

WATER SUPPLY OF WALPOLE.

Population in 1895, 2,994. The works are owned by the town, and were completed in January, 1896. The source of supply is a system of tubular wells in the valley of Low Brook, about a third of a mile above its junction with the Neponset River in the southerly part of the town. The system consists of 7 two and one-half inch tubular wells and 33 two-inch tubular wells, sunk to depths ranging from 35 to 60 feet. The wells are driven in two parallel lines, at right angles to the brook, one extending from the pumping station to the brook and the other line about 50 feet away, extending across the brook. Water from the wells is pumped directly into the distributing pipes and to two covered iron tanks, one at East Walpole, 25 feet in diameter and 45 feet high, and the other at South Walpole, 20 feet in diameter and 35 feet high. Distributing mains are of cast iron, and service pipes are chiefly of wrought iron, lined with cement.

Chemical Examination of Water from the Wells of the Walpole Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		[illegible]	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16111	Feb. 19	None.	V. slight.	.00	3.80	.0000	.0006	.27	.0080	.0000	.01	1.3	.0050
16439	Apr. 20	None.	V. slight.	.00	4.50	.0002	.0008	.30	.0080	.0000	.00	1.1	.0030
16792	June 16	None.	None.	.00	3.00	.0000	.0000	.28	.0020	.0000	.02	0.9	.0000
17229	Aug. 18	None.	None.	.01	3.40	.0004	.0014	.24	.0070	.0000	.04	0.8	.0000
17667	Oct. 19	None.	None.	.00	3.60	.0000	.0004	.27	.0030	.0000	.00	0.9	.0010
18110	Dec. 14	None.	None.	.00	3.20	.0012	.0006	.29	.0020	.0000	.01	1.0	.0000
Av.	....	....	....	.00	3.58	.0003	.0006	.27	.0050	.0000	.01	1.0	.0015

Odor, none. On heating, a faintly earthy odor was developed in the February and August samples. —— The first two samples were collected from a faucet at the pumping station; the remaining samples, from one of the tubular wells at the pumping station.

Microscopical Examination.

An insignificant number of organisms was found in sample No. 16111; no organisms were found in the remaining samples.

WALTHAM.

Water Supply of Waltham.

Chemical Examination of Water from the Well and Filter-basin of the Waltham Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
15927	Jan. 22	None.	None.	.02	7.60	.0040	.0012	.56	.0230	.0000	.06	3.5	.0200
16097	Feb. 19	None.	None.	.02	7.50	.0040	[redacted]	.62	.0270	[redacted]	.04	3.2	.0060
16279	Mar. 18	None.	None.	.04	6.90	.0028	.0050	.66	.0280	.0001	.06	3.4	.0110
16402	Apr. 13	None.	None.	.00	7.50	.0018	.0010	.36	.0220	.0000	.06	3.6	.0120
16642	May 20	None.	None.	.00	7.15	.0006	.0012	.52	.0250	.0000	.04	3.6	.0130
16847	June 22	None.	None.	.05	7.06	.0032	.0016	.54	.0150	.0000	.04	3.6	.0135
16972	July 15	None.	V. slight.	.06	5.20	.0044	.0004	.56	.0100	.0000	–	4.0	.0210
17242	Aug. 19	None.	None.	[redacted]	7.50	.0050	.0012	.40	.0100	.0000	.09	3.9	.0240
17460	Sept. 14	None.	None.	.02	7.30	.0028	.0026	.52	.0140	.0000	.06	3.6	.0100
17661	Oct. 19	V. slight.	V. slight.	.04	7.70	.0046	.0066	.53	.0160	.0000	.08	3.6	[redacted]
17906	Nov. 18	None.	None.	.08	6.95	.0082	.0022	.50	.0200	.0000	.05	3.5	.0165
18177	Dec. 22	None.	None.	.02	6.96	.0046	.0016	.56	.0200	.0000	.06	4.6	.0200

Averages by Years.

–	1887*	–	–	.00	6.71	.0007	.0035	.47	.0250	–	–	–	–
–	1888	–	–	.00	6.70	.0009	.0054	[redacted]	.0275	.0003	–	–	–
–	1889†	–	–	.00	5.44	.0006	.0034	.46	.0362	.0002	–	–	–
–	1890‡	–	–	.00	–	.0000	.0012	.47	.0350	.0002	–	–	–
–	1892	–	–	.00	6.61	.0032	.0027	.45	.0162	.0000	–	3.4	.0034§
–	1893	–	–	.01	6.86	.0036	.0022	.47	.0179	.0000	.06	3.4	.0020
–	1894	–	–	.02	6.76	.0028	.0019	.51	.0192	.0000	.06	3.1	.0044
–	1895	–	–	.02	7.15	.0036	[redacted]	.53	.0198	.0000	.05	3.4	.0082
–	[redacted]	–	–	.03	7.36	.0034	.0018	.55	.0194	.0000	.06	3.6	.0157

* June to December. † January to May. ‡ February. § July to December.

Note to analyses of 1896: Odor of the October sample, faintly mouldy, disappearing on heating; of the others, none. —— The samples collected in August and December were taken from the filter-basin; the other samples, from a faucet at the pumping station.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

WALTHAM.

Chemical Examination of Water from the Distributing Reservoir of the Waltham Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. [redacted]	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	[redacted]												
16028	Jan. 22	Distinct.	Slight.	.04	6.80	.0016	.0090	.58	.0230	[redacted]	[redacted]	3.6	.0100
16096	Feb. 19	Distinct.	V. slight.	.02	7.50	.0030	.0018	.53	.0230	[redacted]	.04	3.2	.0020
16278	Mar. 18	Distinct.	Slight.	.10	7.10	.0006	.0112	.54	.0250	[redacted]	.06	[redacted]	.0050
16391	Apr. 13	Distinct.	Cons., green.	.10	7.80	.0000	.0114	.59	.0180	[redacted]	.06	3.3	.0120
16641	May 20	Slight.	Slight.	.04	7.00	.0002	.0106	.59	.0180	.0002	[redacted]	[redacted]	.0125
16846	June 22	Slight.	Slight.	.06	6.60	.0014	.0102	.58	.0180	.0001	–	3.8	.0085
16971	July 13	Distinct.	Slight, brown	–	8.30	.0012	.0118	.54	[redacted]	.0002	–	3.2	.0060
17243	Aug. 19	V. slight.	V. slight.	.04	7.60	.0006	.0116	.54	.0070	.0001	[redacted]	3.4	.0040
17441	Sept. 14	Slight.	Cons., brown.	.04	7.90	.0026	.0068	.54	.0180	[redacted]	.06	3.6	.0250
17662	Oct. 19	Slight.	Slight.	[redacted]	8.00	[redacted]	.0126	.54	.0170	[redacted]	[redacted]	3.4	[redacted]
17906	Nov. 18	V. slight.	V. slight.	.05	7.20	.0022	.0016	.57	[redacted]	.0000	.04	3.6	.0140
18176	Dec. 22	Distinct, green.	Slight.	.06	7.10	.0014	[redacted]	.57	.0170	.0000	.10	3.4	.0115

Averages by Years.

–	1887*	–	–	.00	5.86	.0007	.0061	.46	0197	–	–	–	–
–	1888	–	–	.00	6.45	[redacted]	.0075	[redacted]	.0248	.0003	–	–	–
–	1889†	–	–	.00	[redacted]	[redacted]	.0079	.47	.0271	.0003	–	–	–
–	1890‡	–	–	[redacted]	–	[redacted]	.0124	.47	.0280	[redacted]	–	–	–
–	1891§	–	–	.00	6.25	.0000	.0044	.40	.0200	.0000	–	[redacted]	–
–	1892	–	–	.01	6.28	.0008	.0082	.44	.0119	.0001	–	3.0	.0070‖
–	1893	–	–	.04	6.72	.0006	.0074	.47	.0127	.0001	.10	3.1	.0019
–	1894	–	–	.03	6.80	.0007	.0140	.51	.0078	.0001	.09	3.1	.0032
–	1895	–	–	[redacted]	7.00	.0016	.0085	.53	.0161	.0000	.09	3.3	.0045
–	1896	–	–	.05	7.40	.0013	.0083	.55	.0172	[redacted]	.07	3.4	.0099

* June to December. † January to May. ‡ February. § May. ‖ August to December.

NOTE to analyses of 1896: Odor, very faint, or [redacted] On heating, an aromatic or disagreeable odor was developed in most of the samples. —— The samples were collected from the reservoir.

WALTHAM.

Microscopical Examination of Water from the Distributing Reservoir of the Waltham Water Works.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	23	21	19	14	22	23	14	20	15	20	20	24
Number of sample,	15928	16096	16278	16391	16641	16848	16971	17243	17441	17662	17906	18178
PLANTS.												
Diatomaceæ,	2,882	2,364	4,890	4,808	3,200	42	0	0	18	140	7	2,324
Asterionella,	2,880	2,360	4,848	4,704	2,000	6	0	0	0	16	7	364
Cyclotella,	0	0	0	0	0	20	0	0	0	0	0	0
Melosira,	0	0	0	0	0	0	0	0	18	0	0	0
Synedra,	2	4	36	104	1,200	16	0	0	0	124	0	1,960
Tabellaria,	0	0	6	0	0	0	0	0	0	0	0	0
Algæ, Raphidium,	0	0	0	0	0	0	0	76	4	0	0	0
ANIMALS.												
Infusoria,	0	3	0	0	0	0	0	0	0	4	0	0
Dinobryon,	0	3	0	0	0	0	0	0	0	0	0	0
Monas,	0	0	0	0	0	0	0	0	0	4	0	0
Vermes, Asplanchna,	0	0	0	0	0	0	0	0	0	4	0	0
Miscellaneous, Acarina,	0	0	0	0	0	.02	0	0	0	0	0	0
TOTAL,	2,882	2,367	4,890	4,808	3,200	42	0	76	22	148	7	2,324

The advice of the State Board of Health to the trustees of the Massachusetts School for the Feeble-minded, in Waltham, relative to the prevention of bad tastes and odors in the water supplied to that institution from the city of Waltham, by covering the iron tank in which the water supplied to the school is stored, may be found on page 23 of this volume.

WALTHAM.

Chemical Examination of Water from Faucets at the Massachusetts School for Feeble-minded, supplied from the Waltham Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16896	June 30	Slight.	Slight, brown.	.04	7.80	.0004	.0026	.56	.0150	.0000	.06	[illegible]	.0110
16897	June 30	V. slight, milky.	Slight.	.04	7.60	.0000	.0022	.56	.0150	.0000	.07	5.5	.0060

Odor, none. —— The first sample was collected from a faucet, while pumping. This water came directly from the Waltham system, without storage in the tank at the school. The last sample was collected from a faucet after the water had been stored in the tank at the school for about 24 hours.

Microscopical Examination.

No. 16896. Diatomaceæ, *Asterionella*, 150; *Synedra*, 6. Miscellaneous, *Zoöglœa*, 20. Total, 176.
No. 16897. Diatomaceæ, *Asterionella*, 50; *Synedra*, 8. Miscellaneous, *Zoöglœa*, 5. Total, 63.

Water Supply of Ware.

The advice of the State Board of Health to the town of Ware relative to the quality of the water supplied to the town may be found on page 43 of this volume.

Chemical Examination of Water from the Wells of the Ware Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16862	June 22	None.	None.	.00	9.60	.0000	.0004	.63	.5250	[illegible]	.01	[illegible]	.0030
17289	Aug. 25	None.	None.	.00	7.70	.0000	.0004	.54	.2250	.0000	.02	5.0	.0000
17290	Aug. 25	V. slight.	Slight.	.00	4.10	.0000	.0004	.14	.0100	.0000	.02	1.6	.0010

Odor, none. On heating, an unpleasant odor was developed in the last sample. —— The first sample was collected from a faucet at the pumping station, while pumping from the large well and tubular wells; the second, from faucet in pumping station while pumping from the large well; the last, from one of the tubular wells.

Microscopical Examination.

No organisms.

WARE.

Chemical Examination of Water from the Open Distributing Reservoir of the Ware Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
16892	1896. June 26	Slight.	Slight.	.02	6.90	.0000	.0050	.42	.0750	.0020	.09	2.4	.0010

Odor, none. —— The sample was collected from the reservoir, no water having been pumped into it for two days previous to the collection of the sample.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

Water Supply of Onset Bay Fire District, Wareham. — Onset Water Company.

Chemical Examination of Water from Jonathan's Pond, Wareham.

[Parts per 100,000.]

Number.	Date of Collection	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
17284	1896. Aug 21	V. slight.	V. slight.	.03	2.80	1.10	.0000	.0082	.0068	.0014	.66	.0020	.0000	.09	0.0

Odor, distinctly vegetable. —— The sample was collected from the pond.

Microscopical Examination.

The total number of organisms per cubic centimeter found in this sample was 146.

WASHINGTON.

Washington.

Chemical Examination of Water from Clapp's Pond, Washington.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15638	Jan. 3	None.	Slight.	1.30	4.60	2.90	.0000	.0262	.0240	.0022	.05	.0130	.0000	1.74	1.1

Odor, faintly vegetable. — The sample was collected from the pond at its outlet.

Microscopical Examination.

The total number of organisms per cubic centimeter found in this sample was 15.

Chemical Examination of Water from Roaring Brook, Washington.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15637	Jan. 3	None.	Slight.	1.20	4.30	2.60	.0002	.0228	.0212	.0016	.04	.0130	.0000	1.64	1.3
16513	May 1	None.	V. slight.	1.25	3.95	2.50	.0008	.0292	.0230	.0012	.05	.0030	.0001	1.39	0.9

Odor of the first sample, none, becoming faintly vegetable on heating; of the second, faintly vegetable. — The samples were collected from Roaring Brook at the first bridge below Clapp's Pond.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

WATER SUPPLY OF WATERTOWN AND BELMONT. — WATERTOWN WATER SUPPLY COMPANY.

Chemical Examination of Water from a Faucet in the Pumping Station of the Watertown Water Supply Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16944	Jan. 22	Distinct.	Slight.	.28	[illegible]	[illegible]	.0036	.74	[illegible]	[illegible]	.18	3.7	.0960
16113	Feb. 19	None.	V. slight.	.15	7.30	.0016	.0054	.64	.0920	.0000	.19	3.9	.0620
16295	Mar. 18	Distinct.	V. slight.	.12	7.40	.0032	.0056	.67	.0880	.0000	.12	3.1	.0280
16401	Apr. 14	None.	V. slight.	.03	7.20	.0000	.0038	.75	.0700	.0000	.07	3.1	.0080
16657	May 21	Slight.	Slight.	.40	8.10	.0264	.0074	.64	.0600	.0001	.18	4.0	.0960
16846	June 22	Distinct, milky	Slight.	.60	8.50	.0192	.0068	.70	.0120	.0001	.34	4.0	.1250
16962	July 18	Distinct, milky.	Slight.	.37	9.[illegible]	.0122	.0048	.60	.0400	.0000	.20	3.7	.1200
17244	Aug. 19	Decided, milky.	Cons.	.65	9.80	.0190	.0088	.72	.0250	.0001	.28	4.4	.1750
17429	Sept. 14	Decided.	Cons.	.93	10.20	.0814	.0068	.82	.0190	.0001	.15	4.6	.2850
17687	Oct. 21	Decided	Cons.	.50	9.[illegible]	.0246	.0072	.69	.0100	.0002	.29	4.3	.3000
17902	Nov. 18	Decided, milky.	Cons., floc.	.60	9.00	.0236	.0096	.67	.0150	.0001	.22	4.1	.3100
18176	Dec. 22	Distinct, milky.	Slight.	.12	8.50	[illegible]	.0168	.76	.0500	.0000	.15	4.1	.0560

Averages by Years.

-	1887*	-	-	.00	7.09	.0005	.0034	.65	.0300	-	-	-	-
-	1888	-	-	.00	7.22	.0000	[illegible]	.63	.0647	[illegible]	-	-	-
-	1889†	-	-	.00	6.45	.0000	.0027	.63	.0610	.0000	-	-	-
-	1890‡	-	-	[illegible]	7.40	.0014	.0042	.69	.0450	[illegible]	-	3.9	-
-	1892§	-	-	.07	7.90	.0041	.0046	.66	.0370	.0001	-	4.0	.0896
-	1893	-	-	.19	7.95	.0063	.0061	.66	.0489	.0001	.13	3.5	.0815
-	[illegible]	-	-	.11	8.82	.0048	.0054	.70	.0542	.0001	.12	[illegible]	.0818
-	1895	-	-	.20	8.75	.0051	.0077	.60	.0669	.0003	.16	3.7	.0627
-	1896	-	-	.40	8.61	.0147	.0070	.71	.0492	.0001	.17	3.8	.1372

* June to December. † January to May. ‡ August. § September to December.

NOTE to analyses of 1896: Odor, generally none, sometimes vegetable, and occasionally mouldy. — The samples were collected from a faucet at the pumping station.

The color of this water is affected by the presence of iron. For a statement as to the effect of the presence of iron upon the color of a ground water, see page 81.

WATERTOWN AND BELMONT.

Microscopical Examination of Water from a Faucet in the Pumping Station of the Watertown Water Supply Company.

[Number of organisms per cubic centimeter.]

	1896. Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	24	22	21	15	23	23	14	20	15	22	20	23
Number of sample,	15944	16113	16295	16401	16657	16846	16962	17244	17439	17687	17902	18176
PLANTS.												
Fungi, Crenothrix,	400	36	0	230	164	204	214	2,000	1,600	1,440	1,600	[illegible]
ANIMALS.												
Infusoria, Peridinium,	0	0	0	0	0	14	0	0	0	0	0	0
TOTAL,	400	36	0	230	161	218	214	2,000	1,600	1,440	1,600	100

Chemical Examination of Water from a Faucet in Watertown supplied from the Works of the Watertown Water Supply Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Sediment.	Color.	Residue on Evaporation.	Ammonia. Free.	Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
15862	Jan. 8	Slight, milky.	V. slight.	.05	9.00	.0004	.0058	.75	.1000	.0000	.09	4.2	.0120
16025	Feb. 4	Slight, milky	V. slight.	.10	9.50	.0000	.0042	.76	[illegible]	.0000	.13	3.9	.0200
16196	Mar. 4	Slight, milky	None.	.10	7.50	.0004	.0062	.62	.1050	.0000	.12	3.4	.0200
16377	Apr. 8	None.	None.	.40	6.60	.0006	.0054	.65	.0700	.0000	.09	3.4	.0100
16549	May 6	Distinct, milky	Slight.	.08	8.70	.0000	.0036	.71	.0600	.0001	.07	4.0	.0300
16728	June 8	Distinct, milky.	Slight.	.22	9.10	.0004	.0064	.67	.0750	.0000	.14	4.3	.0340
16941	July 8	Distinct, milky.	None.	.32	6.50	.0000	.0042	.66	.0250	.0000	.26	4.0	.0450
17131	Aug. 5	Distinct, milky.	V. slight.	.30	10.40	.0010	.0056	.74	.0320	0000	18	4.4	.0480
17376	Sept. 8	Decided, milky.	V slight.	.35	9.70	.0002	.0045	.86	.0200	.0000	15	4.4	.0600
17603	Oct. 7	Decided	Slight.	.25	9.80	.0006	.0044	.71	.0350	.0000	.13	4.4	.0750
17794	Nov. 3	Decided, rusty	Heavy, rusty.	.50	10.80	.0040	.0106	.74	.0500	.0000	.32	4.2	.8600
18011	Dec. 7	Distinct, milky	V. slight.	.20	8.60	.0002	.0034	.70	.0300	.0000	.16	4.2	[illegible]

Averages by Years.

-	1893	-	-	.09	8.06	.0012	.0062	.61	.0426	.0001	.18	3.7	.0166
-	1894	-	-	.11	9.22	.0001	.0042	.71	.0490	.0000	.10	4.6	.0177
-	1895	-	-	.18	9.52	.0016	.0051	.76	.0678	.0001	.10	4.6	.0812
-	1896	-	-	.24	8.97	.0008	.0052	.71	.0561	.0000	.15	4.1	.1041

NOTE to analyses of 1896: Odor, generally none; in August, September, October and November, faintly vegetable; in December, faintly mouldy. —— The samples were collected from a faucet in a house in the easterly part of Watertown.

WATERTOWN AND BELMONT.

Microscopical Examination of Water from a Faucet in Watertown, supplied from the Works of the Watertown Water Supply Company.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	11	7	5	9	7	4	8	6	9	9	6	9
Number of sample,	15862	16025	16196	16377	16549	16728	16941	17131	17376	17608	17794	18011
PLANTS.												
Fungi, Crenothrix,	1	0	0	[redacted]	60	108	0	0	0	60	32,000	240
ANIMALS.												
Infusoria, Peridinium,	0	0	0	7	0	0	[redacted]	0	0	0	0	0
TOTAL,	1	0	0	67	60	108	0	0	0	60	32,000	240

Chemical Examination of Water from Faucets in Watertown, supplied from the Works of the Watertown Water Supply Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	[redacted].												
17206	Aug. 14	Distinct, milky.	Slight.	.35	9.00	.0002	.0058	.74	.0350	.0000	.21	4.2	.0600
17207	Aug. 14	Distinct, milky.	Slight.	.45	9.20	.0098	.0066	.72	.0300	.0012	.25	4.1	.0800

Odor, distinctly mouldy, becoming distinctly vegetable on heating.

Microscopical Examination.

No. 17206. Fungi, *Crenothrix*, 10.
No. 17207. Miscellaneous, *Zoöglœa*, 15.

WAYLAND.

Water Supply of Wayland.

Chemical Examination of Water from the Filter-gallery of the Wayland Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16189	Mar. 3	V. slight.	Slight.	.33	4.35	.0028	.0092	.43	.0350	.0000	.31	1.6	–
17612	Oct. 8	Slight.	Slight.	.33	4.10	.0022	.0270	.30	.0050	.0001	.60	1.6	–

Averages by Years.

–	1894	–	–	.30	4.84	.0122	.0151	.34	.0165	.0000	.30	1.7	.1770
–	1895	–	–	.22	4.80	.0026	.0226	.42	[illegible]	.0002	.68	1.8	–
–	1896	–	–	.33	[illegible]	.0025	.0181	.36	.0215	.0000	.45	1.6	–

NOTE to analyses of 1896: Odor, faintly vegetable, becoming stronger on heating. —— The samples were collected from a faucet in the gate-house.

Microscopical Examination.

No. 16189. Diatomaceæ, *Navicula*, 2. Algæ, *Chlorococcus*, 2. Infusoria, *Dinobryon*, 3; *Euglena*, 1; *Peridinium*, 56; *Trachelomonas*, 2. Total, 66.

No. 17612. Diatomaceæ, *Cyclotella*, 24; *Melosira*, 64; *Navicula*, 8; *Synedra*, 4; *Tabellaria*, 4. Algæ, *Protococcus*, 4. Infusoria, *Dinobryon*, 4; *Mallomonas*, 4; *Trachelomonas*, 36. Total, 152.

Water Supply of Webster.

Chemical Examination of Water from the Well of the Webster Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	[illegible]	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15868	Jan. 13	None.	None.	.00	3.50	.0000	.0002	.29	.0320	.0000	.00	1.6	.0040
16310	Mar. 9	None.	None.	.00	4.20	.0000	.0014	.27	.0350	.0000	.02	1.3	.0000
16576	May 11	None.	None.	.00	3.80	.0008	.0012	.28	.0320	.0000	[illegible]	1.7	.0015
16960	July 11	None.	V. slight.	[illegible]	3.00	.0004	.0008	.27	.0200	.0000	.03	1.8	[illegible]
17452	Sept. 14	None.	None.	.00	3.10	.0000	.0010	.23	.0180	.0000	.05	1.3	.0070
17844	Nov. 11	None.	None.	.00	3.30	.0000	.0004	.22	.0120	.0000	.00	1.2	.0080

WEBSTER.

Chemical Examination of Water from the Well of the Webster Water Works—Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Sediment.	Color.	Residue on Evaporation.	Ammonia. Free.	Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1894	-	-	.01	3.43	.0001	.0006	.21	.0232	.0000	.01	1.4	.0032
-	1895	-	-	.00	4.13	.0000	.0010	.22	.0236	.0000	.02	1.5	.0043
-	1896	-	-	.00	3.68	.0002	.0008	.26	0282	.0000	.01	1.5	.0022

Note to analyses of 1896: Odor, none, except in July, when it was faintly unpleasant, becoming distinctly earthy on heating. —— No. 17844 was collected from a faucet at the pumping station; the others, from the well.

Microscopical Examination.

No organisms.

Water Supply of Wellesley.

The advice of the State Board of Health to the town of Wellesley, relative to securing an additional water supply for the town and the best method of protecting the purity of the present sources of supply, may be found on pages 43 to 46 of this volume.

Chemical Examination of Water from the Filter-gallery of the Wellesley Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Sediment.	Color.	Residue on Evaporation.	Ammonia. Free.	Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
16658	May 22	None.	V. slight.	.00	6.00	.0000	.0012	.55	.0700	.0000	.01	2.7	.0010
16964	July 13	None.	None.	.08	6.70	.0002	.0072	.74	.0100	.0000	.17	2.8	.0010
17443	Sept. 14	None.	Slight.	.05	8.20	.0000	.0026	.71	.0300	.0000	.08	3.8	.0000

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1887*	-	-	.01	7.57	.0002	.0016	.64	.0979	-	-	-	-
-	1888	-	-	.00	6.57	.0001	.0023	.44	.0639	.0000	-	-	-
-	1889†	-	-	.00	6.89	.0005	.0021	.39	.0522	.0000	-	-	-
-	1890‡	-	-	.00	6.85	.0002	.0032	.73	.0400	.0000	-	4.0	-
-	1892§	-	-	.00	7.90	.0000	.0000	.53	.0450	0000	-	3.8	.0000
-	1893‖	-	-	.00	6.70	.0000	.0006	.52	.0600	.0000	.07	2.8	.0050
-	1894¶	-	-	.03	6.60	.0008	.0023	.66	.0465	.0000	.04	2.9	.0030
-	1895**	-	-	.05	6.38	.0006	.0052	.66	.0165	.0000	.12	3.1	.0025
-	[redacted]	-	-	.04	6.97	.0001	.0037	.67	.0367	.0000	.09	3.1	.0007

* June to December. † January to May. ‡ September. § October. ‖ July. ¶ June and October. ** July and August.

Note to analyses of 1896: Odor, none. —— The samples were collected from the filter-gallery.

Microscopical Examination.

No organisms.

WELLESLEY.

Chemical Examination of Water from the Well of the Wellesley Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16659	May 22	None.	V. slight.	.02	5.90	.0000	.0026	.63	.0600	.0000	.06	2.8	.0010
16965	July 13	None.	V. slight.	.06	6.60	.0004	.0038	[illegible]72	.0200	[illegible]	.15	3.4	.0010
17442	Sept. 14	None.	Slight.	.07	7.20	.0000	.0078	[illegible]73	.0250	.0000	.19	3.0	.0040

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
–	1890*	–	–	.00	6.15	.0002	.0042	.73	.1000	[illegible]	–	4.3	–
–	1892†	–	–	.00	6.55	.0000	.0024	.65	.0950	.0001	–	2.4	.0000
–	1893‡	–	–	.00	5.90	.0000	.0014	.60	.0600	.0000	.07	3.3	.0100
–	1894§	–	–	.03	6.10	.0000	.0032	.60	.0515	.0000	.07	2.6	.0015
–	1895‖	–	–	.03	6.85	.0002	.0066	.64	.0340	.0000	.12	3.2	.0005
–	1896	–	–	.05	6.57	.0001	.0047	.69	.0350	.0000	.13	2.7	.0020

* September. † October. ‡ July. § June and October. ‖ July and August.

NOTE to analyses of 1896: Odor, none. On heating, a faintly mouldy odor was developed in the last sample. —— The samples were collected from the well, at Williams Spring.

Microscopical Examination.

An insignificant number of organisms was found in sample No. 17442; no organisms were found in the remaining samples.

Chemical Examination of Water from the Distributing Reservoir of the Wellesley Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16656	May 22	Slight.	V. slight.	.02	8.29	.0006	.0114	.67	.2000	.0010	.04	[illegible]	.0060

Odor, none, becoming faintly mouldy on heating. —— The sample was collected from the reservoir.

Microscopical Examination.

No. 16656. Diatomaceæ, *Melosira*, 5; *Synedra*, 2,800. Total, 2,805.

WELLESLEY.

Chemical Examination of Water from Rosemary Brook in Wellesley.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16665	May 22	Slight.	Slight.	.27	6.16	1.15	.0024	.0208	.0196	.0012	.69	.0500	.0008	.29	2.5

Odor, decidedly mouldy. —— The sample was collected from the brook, near the pumping station of the Wellesley Water Works.

Microscopical Examination.

An insignificant number of organisms was found in this sample.

Chemical Examination of Water from Test Wells in Wellesley.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
17792	Nov. 4	Slight.	Cons., earthy.	.01	6.40	.0000	.0002	.48	.2000	.0000	.01	2.7	.0060
17793	Nov. 4	None.	Slight, earthy.	.01	6.20	.0000	.0000	.48	.2200	.0000	.01	2.3	.0040
17772	Nov. 2	None.	V. slight	.00	5.90	.0000	.0008	.46	.1600	.0001	.00	2.2	.0060
17773	Nov. 2	None.	None.	.00	5.80	.0000	.0002	.48	.2000	.0000	.00	2.2	.0080
17781	Nov. 3	None.	Slight.	.00	6.80	.0000	.0002	.46	.1800	.0000	.00	2.2	.0070
17782	Nov. 3	None.	V. slight.	.00	6.80	.0000	.0008	.47	.2400	.0000	.00	2.2	.0010
17823	Nov. 10	Distinct.	Slight	.01	6.00	.0004	.0004	.40	.0950	.0000	.00	2.6	.0080
17824	Nov. 10	None.	V. slight.	.00	6.10	.0002	.0006	.39	.0900	.0000	.00	2.4	.0020
17795	Nov. 5	None	V. slight	.00	6.30	.0000	.0004	.50	.2100	.0000	.01	2.2	.0050
17796	Nov. 5	None	V. slight.	.00	6.10	.0000	.0008	.48	.2200	.0000	.01	2.2	.0020
17797	Nov. 7	V. slight.	Slight, earthy.	.02	7.70	.0008	.0010	.68	.0500	.0000	.00	3.2	.0020
17798	Nov. 7	None.	Slight.	.00	7.50	.0010	.0008	.66	.0500	.0000	.00	3.2	.0040
17845	Nov. 11	Distinct, milky.	Cons., clayey	.02	3.80	.0000	.0002	.31	.0080	.0000	.00	1.6	.0050
17846	Nov. 11	None.	V. slight.	.03	3.80	.0000	.0000	.31	.0070	.0000	.01	1.4	.0040
17862	Nov. 13	Distinct, milky	Cons.	.00	7.10	.0002	.0004	.67	.0180	.0000	.00	3.1	.0030
17863	Nov. 13	V. slight	Slight.	.00	6.80	.0000	.0002	.67	.0100	.0000	.00	3.3	.0030
17969	Nov. 28	Decided	Cons.	.03	7.30	.0000	.0000	.47	.0050	.0000	.03	1.9	.0080
17995	Dec. 3	Distinct, clayey	Slight, sandy	.00	5.80	.0002	.0000	.44	.1400	.0000	.03	2.5	.0040
17996	Dec. 3	None.	None	.00	6.10	.0002	.0020	.43	.1100	.0000	.03	2.7	.0010
17999	Dec. 5	None	V. slight	.00	6.00	.0000	.0000	.48	.1150	.0000	.00	2.6	.0000

Odor of No. 17969, distinctly disagreeable, becoming earthy and mouldy on heating; of the others, none. —— The samples were collected as follows: Nos. 17792 and 17793, from a tubular well numbered 6, about 900 feet west of Cedar Street and 45 feet east of Rosemary Brook; Nos. 17772 and 17773, from test well numbered 7, located about 600 feet west of Cedar Street and 25 feet north of Rosemary Brook; Nos. 17781 and 17782, from test well numbered 14, about 975 feet west of Cedar Street and 30 feet south of Rosemary Brook; Nos. 17823 and 17824, from test well numbered 16, about 1,100 feet west of Cedar Street and 500 feet north of Worcester Street; Nos. 17795 and 17796, from test well numbered 17, about 1,200 feet west of Cedar Street, 100 feet north of Worcester Street and 50 feet from Rosemary Brook; Nos. 17797 and 17798, from test well numbered 22, about 100 feet south of Worcester Street and 120 feet south of Rosemary Brook; Nos. 17845 and 17846, from test well numbered 23, located about 400 feet south of Worcester Street, 1,400 feet west of Cedar Street and 450 feet from Rosemary Brook; Nos. 17862 and 17863, from test well numbered 24, 350 feet south of Worcester Street and 350 feet north-east of Longfellow's Pond; Nos. 17969 and 17995, from a group of 5 wells in the valley of Rosemary Brook on the northerly side of the Worcester turnpike, while pumping with a steam pump, and the last two samples, Nos. 17996 and 17999, while pumping from four of these wells.

Microscopical Examination.

No organisms.

WESTBOROUGH.

Water Supply of Westborough.

Chemical Examination of Water from the Upper Sandra Reservoir, Westborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16330	Mar. 26	Distinct.	Slight.	.20	2.50	0.75	.0082	.0112	.0094	.0018	.17	.0100	.0000	.29	1.1
16789	June 15	Distinct.	Slight, green.	.27	2.15	1.00	.0046	.0326	.0184	.0142	.13	.0000	.0000	.38	0.2
17477	Sept. 16	Distinct, green.	Cons.	.20	2.95	1.70	.0000	.0378	.0200	.0178	.21	.0000	.0000	.42	0.1
18120	Dec. 14	Distinct.	Slight.	.27	3.20	1.75	.0006	.0246	.0192	.0054	.26	.0020	.0000	.62	0.5

Averages by Years.

-	1894	-	-	.30	3.32	1.67	.0061	.0384	.0200	.0184	.21	.0023	.0000	.47	0.4
-	1895	-	-	.30	3.09	1.55	.0079	.0369	.0235	.0134	.23	.0057	[illegible]	.46	0.4
-	1896	-	-	.22	2.70	1.30	.0033	.0265	.0167	.0098	.20	.0030	.0000	[illegible]	0.5

Note to analyses of 1896. Odor of the first sample, faintly vegetable and mouldy, becoming distinctly vegetable on heating; of the second, decidedly disagreeable, becoming decidedly grassy on heating; of the others, unpleasant. —— The samples were collected from the upper reservoir.

Microscopical Examination of Water from the Upper Sandra Reservoir, Westborough.

[Number of organisms per cubic centimeter.]

	1896. March.	1896. June.	1896. Sept.	1896. Dec.
Day of examination,	27	16	17	16
Number of sample,	16330	16789	17477	18120
PLANTS.				
Diatomaceæ,	1	660	472	40
Asterionella,	[illegible]	16	10	2
Cyclotella,	0	0	0	[illegible]
Cymbella,	0	0	[illegible]	0
Fragilaria,	0	42		0
Melosira,	0	90	266	0
Meridion,	0	6	0	0
Navicula,	0	30	2	0
Pinnularia,	0	6	2	0
Synedra,	1	336	190	28
Tabellaria,	0	90	8	0

WESTBOROUGH.

Microscopical Examination of Water from the Upper Sandra Reservoir, Westborough — Concluded.

[Number of organisms per cubic centimeter.]

	1896.			
	March.	June.	Sept.	Dec.
PLANTS — Con.				
Cyanophyceæ,	0	34	4	0
Clathrocystis,	0	24	2	0
Cœlosphærium,	0	10	0	0
Microcystis,	0	0	2	0
Algæ,	13	268	322	34
Arthrodesmus,	0	88	0	0
Cœlastrum,	0	2	0	0
Cosmarium,	0	2	0	0
Dictyosphærium,	0	0	40	0
Pediastrum,	0	2	2	0
Protococcus,	13	20	2	0
Raphidium,	0	0	34	8
Scenedesmus,	0	52	12	2
Selenastrum,	0	96	24	0
Staurastrum,	0	6	208	20
Zoöspores,	0	0	0	4
ANIMALS.				
Infusoria,	72	34	28	142
Ciliated infusorian,	0	0	2	0
Dinobryon,	32	26	0	0
Mallomonas,	0	0	2	0
Monas,	0	6	4	48
Peridinium,	40	0	18	92
Synura,	0	2	0	0
Trachelomonas,	0	0	2	2
Vermes,	0	4	16	0
Anurea,	0	4	4	0
Polyarthra,	0	0	6	0
Rotatorian ova,	0	0	2	0
Rotifer,	0	0	4	0
Crustacea, Cyclops,	0	.04	0	0
Miscellaneous,	0	20	20	10
Acarina,	0	.04	0	0
Zoöglœa,	0	20	20	10
TOTAL,	86	960	862	226

WESTBOROUGH.

Chemical Examination of Water from the Lower Sandra Reservoir, Westborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16331	Mar. 26	Distinct.	Slight.	.15	2.55	0.75	.0004	.0106	.0086	.0020	.17	.0080	.0000	.26	0.6
16790	June 15	Slight.	Slight.	.10	2.75	0.90	.0002	.0098	.0084	.0014	.21	.0000	.0000	.19	0.9
17478	Sept. 16	Slight.	Slight.	.10	[illegible]	1.05	.0000	.0080	.0070	.0010	.22	.0020	.0000	.13	1.3
18121	Dec. 14	Slight.	Slight.	.17	3.55	1.80	.0006	.0186	.0130	.0056	.26	.0000	.0000	.35	1.1

Averages by Years.

-	1894	-	-	.07	3.15	1.16	.0009	.0126	.0092	.0034	.22	[illegible]	.0000	.19	0.9
-	1895	-	-	.16	3.08	1.25	.0011	[illegible]	.0127	.0040	.24	.0045	[illegible]	.29	0.9
-	1896	-	-	.13	[illegible]	1.00	.0003	.0117	.0092	.0025	.21	.0025	.0000	[illegible]	1.0

NOTE to analyses of 1896: Odor of the first two samples, faintly vegetable; of the third, distinctly grassy and mouldy; of the last, faintly unpleasant. —— The samples were collected from the lower reservoir.

Microscopical Examination of Water from the Lower Sandra Reservoir, Westborough.

[Number of organisms per cubic centimeter.]

	1896.			
	March.	June.	Sept.	Dec.
Day of examination,	27	16	17	16
Number of sample,	16331	16790	17478	18121
PLANTS.				
Diatomaceæ,	0	19	3	30
Cyclotella,	0	2	0	0
Melosira,	0	12	0	0
Navicula,	0	2	2	[illegible]
Nitzschia,	0	0	0	2
Synedra,	0	1	1	23
Tabellaria,	0	2	0	[illegible]
Algæ,	40	0	1	122
Dictyosphærium,	0	0	0	2
Protococcus,	40	0	1	2
Raphidium,	0	0	0	2
Staurastrum,	0	0	0	116

WESTBOROUGH.

Microscopical Examination of Water from the Lower Sandra Reservoir, Westborough — Concluded.

[Number of organisms per cubic centimeter.]

	1896.			
	March.	June.	Sept.	Dec.
ANIMALS.				
Infusoria,	202	0	1	186
Cryptomonas,	0	0	0	4
Dinobryon,	190	0	0	8
Monas,	0	0	0	148
Peridinium,	12	0	1	26
Vermes,	0	0	0	6
Anuraea,	0	0	0	2
Polyarthra,	0	0	0	4
Crustacea, Cyclops,	0	.02	0	0
Miscellaneous, Zoöglœa,	0	5	5	10
TOTAL,	242	24	10	356

WATER SUPPLY OF WESTBOROUGH INSANE HOSPITAL, WESTBOROUGH.

Chemical Examination of Water from the Tubular Wells at the Westborough Insane Hospital.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1896.												
16788	June 15	Distinct, milky	Slight.	.47	10.90	.1360	.0040	.38	.0000	.0002	.18	6.0	.1400
17474	Sept. 16	Distinct, milky.	Slight.	.52	11.40	.1240	.0044	.38	.0070	.0001	.14	6.3	.1520
					Averages by Years.								
–	1887*	–	–	.03	11.29	.0407	.0033	.42	.0030	–	–	–	–
–	1888	–	–	.06	11.27	.0802	.0051	.42	.0045	.0000	–	–	–
–	1889†	–	–	.16	11.41	.0530	.0049	.43	.0030	.0000	–	–	–
–	1891‡	–	–	.50	11.80	.0784	.0109	.45	.0040	.0000	–	6.0	–
–	1893§	–	–	.33	11.09	.0758	.0056	.40	.0078	.0001	.12	5.8	.0964
–	1894	–	–	.39	11.75	.1188	.0082	.37	.0007	.0000	.15	6.1	.1697
–	1895‖	–	–	.55	12.17	.1197	.0024	.40	.0017	.0001	.12	5.9	.1473
–	1896	–	–	.49	11.15	.1300	.0042	.38	.0035	.0001	.16	6.1	.1460

* June to December. † January to May. ‡ July, two samples.
§ January, March, May and July. ‖ February, May and August.

NOTE to analyses of 1896: Odor of the first sample, faintly vegetable; of the second, distinctly unpleasant. —— The samples were collected from a faucet at the pumping station, while pumping from the wells.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

WESTBOROUGH.

Chemical Examination of Water from Chauncy Pond, Westborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16255	Mar. 16	V. slight.	V. slight.	.70	4.60	2.16	.0118	.0242	.0232	.0010	.41	.0180	.0006	.79	1.4
18111	Dec 14	None.	Slight.	.33	4.35	1.70	.0018	.0220	–	–	.44	.0090	.0001	.63	2.1

Note to analyses of 1896: Odor, faintly vegetable. —— The samples were collected from a faucet at the pumping station, while pumping from the pond.

Microscopical Examination.

An insignificant number of organisms was found in the first sample; no organisms were found in the last sample.

Water Supply of Westfield.

Chemical Examination of Water from the Westfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16440	Apr. 19	V. slight.	Slight.	.58	2.25	1.00	.0012	.0178	.0150	.0028	.06	.0030	.0000	.59	0.5
16729	June 3	Slight.	Slight.	.40	2.50	0.60	.0010	.0182	.0170	.0012	.10	.0000	.0000	.51	0.2
17187	Aug. 9	Distinct.	Slight.	.70	3.30	2.05	.0062	.0210	.0204	.0006	.07	.0000	.0000	.82	0.1
17640	Oct. 13	Slight.	Slight.	.70	2.60	1.55	.0006	.0278	.0200	.0078	.10	.0030	.0000	.87	0.5
18136	Dec. 16	Slight.	Slight.	.65	3.05	1.60	.0006	.0210	.0158	.0052	.14	.0030	.0001	.72	0.6
Av.	....	....	....	.61	2.74	1.36	.0019	.0211	.0176	.0035	.09	.0018	.0000	.70	0.4

Odor, vegetable and sometimes mouldy. —— No. 16729 was collected from the distributing reservoir, and the others from the storage reservoir.

WESTFIELD.

Microscopical Examination of Water from the Westfield Water Works.

[Number of organisms per cubic centimeter.]

	1896.				
	April.	June.	August.	October.	December.
Day of examination,	22	4	13	15	17
Number of sample,	16440	16729	17187	17640	18136
PLANTS.					
Diatomaceæ,	38	8	225	238	10
Asterionella,	0	3	108	92	3
Cyclotella,	0	0	2	0	0
Diatoma,	0	0	0	6	0
Melosira,	0	0	0	0	7
Meridion,	6	0	0	0	0
Navicula,	3	1	0	0	0
Synedra,	8	4	3	0	0
Tabellaria,	21	0	112	140	0
Algæ,	300	1	1	14	0
Cosmarium,	0	1	0	2	0
Protococcus,	300	0	1	4	0
Raphidium,	0	0	0	8	0
ANIMALS.					
Infusoria,	0	2	0	24	49
Cryptomonas,	0	0	0	4	0
Mallomonas,	0	1	0	4	0
Monas,	0	0	0	4	0
Peridinium,	0	0	0	8	48
Tintinnidium,	0	0	0	2	0
Trachelomonas,	0	1	0	2	1
Miscellaneous, Zoöglœa,	0	30	80	60	10
TOTAL,	338	41	306	336	69

WATER SUPPLY OF WESTON. — WESTON AQUEDUCT COMPANY.

Population in 1895, 1,710. The works are owned by the Weston Aqueduct Company, and water was first introduced in January, 1896. The source of supply is a well situated in the valley of Cherry Brook. The well is 11 feet in diameter and 25 feet deep, built of stone laid without mortar and covered with a wooden roof. Water is forced from the well to the town and to a covered distributing reservoir 50 feet in diameter and 15 feet deep, built of stone and lined with cement. Distributing mains are of cast iron, service pipes are of galvanized iron.

WESTON.

Chemical Examination of Water from the Well of the Weston Aqueduct Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16883	June 24	Slight, milky	None.	.02	7.30	.0000	.0010	.40	.0430	.0001	.05	3.4	.0030
16966	July 14	None.	None.	.02	6.50	.0000	.0004	.40	.0400	.0008	.04	2.9	.0020
17189	Aug. 12	None.	V. slight.	.01	7.30	.0000	.0016	.38	.0450	.0001	.04	3.2	.0030
17449	Sept. 14	None.	None.	.01	7.00	.0000	.0024	.41	.0350	.0000	.02	3.6	.0040
17635	Oct. 12	None.	V. slight.	.02	7.10	.0000	.0010	.40	.0400	.0001	.03	3.2	.0010
17895	Nov. 16	None.	None.	.00	7.30	.0000	.0042	.46	.0400	.0000	.00	3.2	.0000
18155	Dec. 17	None.	V. slight.	.00	6.40	.0004	.0028	.48	.0600	.0000	.04	3.0	.0000
Av.	....	....	....	.01	6.99	.0001	.0019	.41	.0433	.0001	.03	3.2	.0019

Odor, none. On heating, a faintly mouldy odor was developed in the June sample, and a faintly vegetable odor in the August, September and October samples. —— The samples were collected from the well.

Microscopical Examination.

No organisms.

Water Supply of Weymouth.

Chemical Examination of Water from Great Pond, in Weymouth.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16260	Mar. 16	V. slight.	V. slight.	1.20	4.65	2.35	.0006	.0180	.0156	.0024	.51	.0080	.0000	1.03	0.8
16759	June 9	V. slight	Slight.	0.95	3.80	1.90	.0000	.0210	.0184	.0026	.48	.0030	.0001	0.85	0.5
17499	Sept 16	Distinct.	Slight.	0.47	3.65	1.90	.0006	.0180	.0162	.0018	.60	.0050	.0000	0.54	0.4
18129	Dec. 15	None.	Slight.	0.65	3.90	1.75	.0008	.0166	.0142	.0024	.69	.0020	.0001	0.69	0.9

Averages by Years.

-	1887*	-	-	0.93	4.08	1.75	.0007	.0219	-	-	.47	.0030	-	-	-
-	1888†	-	-	0.88	4.16	1.94	.0020	.0225	-	-	.48	.0074	.0000	-	-
-	1889‡	-	-	1.40	-	-	.0000	.0230	.0220	.0010	-	.0040	.0000	-	-
-	1892	-	-	0.94	3.82	1.86	.0000	.0173	.0156	.0017	.51	.0077	.0000	-	0.4
-	1893	-	-	0.76	3.86	1.66	.0003	.0163	.0139	.0025	.57	.0008	.0000	0.68	0.5
-	1894	-	-	0.77	3.99	1.60	.0003	.0169	.0156	.0013	.61	.0015	.0000	0.67	0.7
-	1895	-	-	0.82	4.07	1.99	.0005	.0196	.0183	.0015	.56	.0040	.0000	0.80	0.6
-	1896	-	-	0.82	4.00	1.97	.0005	.0184	.0161	.0023	.57	.0045	.0000	0.78	0.6

* June to December. † January to May. ‡ July.

Note to analyses of 1896: Odor, vegetable. —— The samples were collected from faucets in the town, supplied with water from the pond.

Microscopical Examination.

No. 16260. No organisms.
No. 16759. Miscellaneous, *Zoöglœa*, 20.
No. 17499. Miscellaneous, *Zoöglœa*, 5.
No. 18129. Diatomaceæ, *Asterionella*, 5. Miscellaneous, *Zoöglœa*, 5. Total, 10.

WATER SUPPLY OF WHITMAN.

Chemical Examination of Water from the Filter-gallery of the Whitman Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
16193	Mar. 4	Distinct, clayey.	Slight, earthy.	.35	4.70	1.60	.0022	.0160	.0144	.0016	0.57	.0250	.0000	.60	1.4
17373	Sept. 8	Slight	Slight.	.38	6.60	2.20	.0024	.0300	.0272	.0028	1.02	.0000	.0000	.53	2.3

Odor, faintly vegetable. —— The first sample was collected from a faucet on pipe line near the pumping station, and the other from the filter-gallery.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows: No. 16193, 13; No. 17373, 264.

Chemical Examination of Water from Hobart's Pond, Whitman.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
16194	Mar. 4	Distinct, clayey.	Cons., earthy.	.50	4.40	1.60	.0016	.0322	.0272	.0050	0.51	.0170	.0001	.68	1.5
17374	Sept. 8	Slight.	Slight.	.33	6.60	2.20	.0000	.0336	.0318	.0018	1.06	.0000	.0000	.54	2.1

Odor, faintly vegetable. —— The samples were collected from the pond.

Microscopical Examination.

The total number of organisms per cubic centimeter found in these samples was as follows: No. 16194, 11; No. 17374, 330.

WILLIAMSBURG.

The advice of the State Board of Health to the town of Williamsburg, relative to taking a public water supply from the east branch of Mill River in that town, may be found on pages 46 to 48 of this volume. Analyses of samples of water collected from the tributaries of Mill Brook are given below.

Chemical Examination of Water from the Tributaries of Mill River in Williamsburg.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16061	Feb. 11	V. slight.	V. slight.	.30	2.40	0.75	.0006	.0098	.0084	.0014	.06	.0050	.0000	.36	1.3
17228	Aug 17	Slight.	Slight.	.17	4.90	1.00	.0000	.0080	.0064	.0016	.09	.0000	.0000	.22	2.7
17429	Sept. 9	V. slight.	Slight.	.42	6.90	2.45	.0012	.0170	.0140	.0030	.10	.0070	.0001	.55	[illegible]
16062	Feb. 11	V. slight.	V. slight.	.15	2.70	0.85	.0000	.0070	.0060	.0010	.06	.0050	.0001	.23	1.2
17227	Aug. 17	None.	V. slight.	.05	3.35	0.70	.0004	.0042	.0032	.0010	.08	.0030	.0000	.10	1.9
17428	Sept. 9	V. slight.	V. slight.	.10	4.50	1.20	.0016	.0054	.0044	.0010	.10	.0030	.0000	[illegible]	1.6
16063	Feb. 11	Slight.	Slight, earthy.	.18	2.65	0.95	.0000	.0074	.0064	.0010	.08	.0050	.0000	.31	1.0

Odor of No. 16063, faintly vegetable; of the others, none. On heating, a faintly vegetable odor was developed in Nos. 16061 and 16062, and a faintly earthy odor in No. 17428. —— Nos. 16061, 17228 and 17429 were collected from the Bradford branch of east branch of Mill River; Nos. 16062, 17227 and 17428 were collected from the Conway branch of east branch of Mill River, at site of old reservoir; and No. 16063, from Goshen branch of Mill River, at bridge above Williamsburg.

Microscopical Examination.

The total number of organisms per cubic centimeter found in each of these samples was as follows: No. 16061, 3; No. 17228, 35; No. 17429, 12; No. 16062, 8; No. 17227, 4; No. 17428, 7; No. 16063, 8.

WATER SUPPLY OF WILLIAMSTOWN. — WILLIAMSTOWN WATER COMPANY.

Water from the Flora Glen Reservoir was used for the first time in the summer of 1896, but, owing to complaints in regard to the quality of the water, its use was discontinued in August. The advice of the State Board of Health to the Williamstown Water Company with reference to possible pollution of the water of Flora Glen Reservoir from a house upon its watershed may be found on pages 76 and 77 of this volume.

WILLIAMSTOWN.

Chemical Examination of Water from Cold Spring Reservoir, Williamstown.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16147	Feb. 25	None.	V. slight.	.03	12.30	.0002	.0022	.04	.0380	.0000	.01	11.1	.0060
16504	Apr. 28	None.	None.	.00	13.50	.0000	.0034	.05	.0300	.0000	.02	13.3	.0000
16677	June 23	None.	Slight.	.00	13.70	.0000	.0012	.05	.0450	.0000	.05	13.5	.0010
17293	Aug. 25	None.	None.	.00	12.90	.0000	.0012	.06	.0350	[redacted]	.02	12.0	.0010
17738	Oct. 27	V. slight.	Slight.	.02	11.20	.0040	.0026	.07	.0220	.0000	.02	11.2	.0050
18161	Dec. 22	None.	V. slight.	.00	12.10	.0000	.0012	.07	.0300	.0000	.01	12.4	–
Av.	....	....	....	.01	12.62	.0007	.0020	.06	.0338	.0000	.02	12.2	.0026

Odor, none. —— Nos. 17293 and 18161 were collected from faucets, and the others from the reservoir.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

Chemical Examination of Water from Sherman Spring Reservoir, Williamstown.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16148	Feb. 25	None.	V. slight.	.00	4.50	.0004	.0020	.05	.0100	.0000	.01	2.3	.0040
16503	Apr. 28	None.	None.	.01	6.90	.0032	.0042	.06	.0070	.0000	.07	5.0	.0000
16678	June 23	Slight.	Slight.	.03	6.40	.0006	.0060	.06	.0050	.0003	.07	4.4	.0010
17294	Aug. 25	Slight.	Slight.	.05	6.70	.0088	.0142	.04	.0000	.0001	.09	4.9	.0010
17739	Oct. 27	None.	Slight.	.00	12.10	.0006	.0030	.06	.0200	.0000	.01	10.6	.0050
18172	Dec. 22	None.	V. slight.	.00	6.30	.0006	.0012	.07	.0080	.0000	.02	4.9	.0000
Av.	....	....	....	.01	7.15	.0024	.0051	.06	.0083	.0001	.04	5.3	.0018

Odor of No. 16878, distinctly unpleasant; of the others, none. On heating, a distinctly fishy odor was developed in No. 17294 and a distinctly earthy odor in No. 17739. —— The samples were collected from the reservoir.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

WILLIAMSTOWN.

Chemical Examination of Water from Flora Glen Reservoir, Williamstown.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
16148	Feb. 25	None.	V. slight	.03	4.30	0.35	.0016	.0032	.0024	.0008	.05	.0100	.0004	.03	2.6
16501	Apr. 28	None.	Slight.	.01	3.70	0.35	.0004	.0054	.0030	.0024	.06	.0070	.0000	.06	2.6
16676	June23	Distinct, milky.	Slight.	.03	5.90	0.60	.0008	.0056	.0046	.0010	.05	.0030	.0001	.11	4.1
17292	Aug 25	Slight.	Slight.	.10	6.95	0.80	.0014	.0126	.0092	.0034	.03	.0020	.0001	.16	4.6
17[illegible]7	Oct. 27	Slight, clayey.	Slight.	[illegible]	6.70	0.00	.0020	.0084	.0070	.0014	.13	.0030	.0000	.10	2.3
18163	Dec. 22	None.	V. slight.	.01	4.60	–	.0002	.0024	–	–	.06	.0050	.0000	.04	2.6
Av....	......	....	....	.04	5.31	0.40	.0011	.0070	.0052	.0018	.07	.0052	.0000	.09	3.4

Odor, in August, decidedly disagreeable; at other times, none. On heating, a distinctly earthy odor was developed in the June sample. —— The samples were collected from the reservoir.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

Chemical Examination of Water from Paul Brook Reservoir, Williamstown.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
16145	Feb 25	None.	Slight.	.00	3.95	1.05	.0002	.0028	.0020	.0008	.04	.0220	.0000	.01	3.1
16502	Apr. 28	None	V. slight.	.00	2.05	0.50	.0000	.0018	.0018	.0000	.06	.0030	.0000	.04	2.2
16875	June23	Slight.	Cons.	.00	3.90	0.50	.0008	.0070	.0036	.0034	.06	.0070	.0000	.10	2.7
17291	Aug 25	V slight	Cons.	.02	4.20	0.60	.0020	.0046	.0032	.0014	.06	.0100	.0000	.06	2.7
17736	Oct 27	None.	V slight.	.02	4.50	0.20	.0000	.0022	.0018	.0004	.07	.0000	.0000	.09	2.9
18180	Dec. 22	None.	V. slight.	.01	4.10	0.40	[illegible]	.0026	.0024	.0002	.07	.0050	.0000	.03	3.1
Av....	......	....	....	.01	4.03	0.54	.0005	.0035	.0025	.0010	.06	.0078	.0000	.05	2.8

Odor in April, distinctly earthy; in June, faintly unpleasant; at other times, none. —— The samples were collected from the reservoir.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

Water Supply of Winchendon.

Population in 1895, 4,490. The works are owned by the town, and water was introduced in December, 1896. The source of supply is a covered masonry well 28½ feet in diameter and 25 feet deep, located in Prentiss Meadow, in the valley of Miller's River, about 1½ miles south-east of the village. The supply obtained from the well is supplemented by a line of 12-inch tiled pipe, which has been laid with open joints, extending from the well a distance of about 375 feet, with short branches at frequent intervals, the total length of pipe being about 1,065 feet. This pipe has been laid about 5 feet beneath the surface of the ground. Water is pumped from the well to the town and to a covered masonry reservoir 13,000 feet distant from the pumping station. The distributing reservoir is circular in form, having a diameter of 70 feet and a depth of 19 feet. Service pipes are of wrought iron coated with tar.

Water Supply of Winchester.

Chemical Examination of Water from the North Reservoir of the Winchester Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15846	Jan. 7	Decided.	Slight.	.18	7.00	1.95	.0010	.0224	.0194	.0030	1.03	.0180	.0002	.34	2.9
16011	Feb. 4	V slight	V slight.	.12	7.35	3.40	.0040	.0184	.0166	.0018	1.00	.0280	.0003	.36	2.6
16182	Mar. 3	Slight, milky	Slight.	.12	6.50	1.70	.0102	.0192	.0180	.0012	0.77	.0200	.0003	.29	2.5
16367	Apr. 7	Distinct.	Slight.	.12	6.00	1.65	.0012	.0192	.0138	.0054	0.76	.0380	.0000	.33	2.7
16539	May 5	Distinct, white.	Slight.	.10	5.85	1.70	.0016	.0204	.0174	.0030	0.80	.0180	.0002	.24	2.4
16711	June 2	Decided	Slight.	.12	5.80	1.80	.0012	.0234	.0152	.0082	0.77	.0070	.0002	.32	2.9
16925	July 7	V. slight.	Slight.	.12	5.95	1.60	.0002	.0220	.0136	.0084	-	.0030	.0000	.29	2.5
17124	Aug 4	Decided	Cons., green	.08	5.90	1.80	.0000	.0222	.0172	.0050	0.82	.0000	.0000	.30	2.6
17349	Sept. 2	Distinct.	Slight.	.15	6.60	1.60	.0004	.0276	.0212	.0064	0.82	.0000	.0001	.36	2.5
17583	Oct. 5	Distinct	Slight.	.05	5.90	1.70	.0010	.0352	.0220	.0132	0.82	.0000	.0000	.40	2.5
17776	Nov. 3	Decided, green	Cons., green.	.12	7.10	2.45	.0008	.0278	.0212	.0066	0.86	.0020	.0001	.29	2.6
17966	Dec. 2	Decided.	Slight.	.12	6.05	1.90	.0054	.0320	.0200	.0120	0.92	.0050	.0000	.34	2.7

Averages by Years

-	1887*	-	-	.11	5.09	1.18	.0015	.0196	-	-	0.53	.0037	-	-	-
-	1888	-	-	.15	4.93	1.24	.0045	.0273	-	-	0.47	.0131	.0003	-	-
-	1889	-	-	.14	4.52	1.16	.0022	.0222	.0175	.0047	0.47	.0105	.0003	-	-
-	1890	-	-	.09	5.30	1.31	.0017	.0201	.0160	.0041	0.57	.0153	.0002	-	2.7
-	1891	-	-	.10	4.94	1.39	.0034	.0222	.0169	.0053	0.51	.0152	.0001	-	2.1
-	1892	-	-	.06	5.23	1.59	.0058	.0217	.0177	.0040	0.60	.0192	.0002	-	2.5
-	1893	-	-	.07	5.13	1.62	.0055	.0252	.0172	.0080	0.59	.0127	.0002	.27	2.3
-	1894	-	-	.09	5.85	1.86	.0017	.0198	.0160	.0038	0.82	.0076	.0001	.25	2.5
-	1895	-	-	.11	6.50	2.05	.0024	.0203	.0169	.0034	0.91	.0183	.0002	.29	2.6
-	1896	-	-	.12	6.32	1.94	.0022	.0242	.0184	.0058	0.85	.0116	.0001	.32	2.6

* June to December.

Note to analyses of 1896: Odor, generally distinctly vegetable, occasionally mouldy or unpleasant; in June, distinctly fishy and oily. —— The samples were collected from the reservoir

WINCHESTER.

Microscopical Examination of Water from the North Reservoir of the Winchester Water Works.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar	Apr.	May	June	July.	Aug	Sept	Oct.	Nov.	Dec.
Day of examination,	8	5	4	8	6	3	7	5	8	6	4	3
Number of sample,	15848	16011	16182	16367	16530	16711	16925	17124	17349	17563	17776	17956
PLANTS.												
Diatomaceæ,	7,260	0	110	318	[illegible]	150	[illegible]	132	547	386	162	4
Asterionella,	7,189	0	94	156	54	10	0	2	[illegible]	12	0	0
Cyclotella,	5	0	0	0	0	0	2	104	500	6	96	2
Diatoma,	0	0	0	6	0	0	0	0	0	0	0	0
Melosira,	0	0	0	0	40	68	0	20	44	360	52	0
Navicula,	0	0	0	0	2	0	0	0	0	2	4	0
Nitzschia,	0	0	0	2	0	0	0	6	0	0	0	0
Stephanodiscus,	0	0	12	8	64	28	0	0	0	0	0	2
Synedra,	0	0	4	116	24	6	1	0	3	4	0	0
Tabellaria,	67	0	0	30	84	38	0	0	0	0	0	0
Cyanophyceæ,	0	0	0	0	0	18	1	0	5	4	14	1
Anabæna,	0	0	0	0	0	4	0	0	4	0	10	1
Microcystis,	0	0	0	0	0	14	1	0	1	4	4	0
Algæ,	165	2	18	30	10	80	64	92	141	392	1,226	36
Protococcus,	124	2	0	0	0	2	0	0	0	2	2	2
Raphidium,	11	0	[illegible]	30	10	76	64	92	140	388	1,200	34
Scenedesmus,	0	0	0	0	0	2	0	0	1	2	24	0
Selenastrum,	30	0	0	0	0	0	0	0	0	0	0	0
ANIMALS.												
Infusoria,	0	0	3	14	10	26	[illegible]	10	6	4	[illegible]	4
Dinobryon,	0	0	0	2	0	2	0	0	0	0	0	0
Mallomonas,	0	0	0	0	0	0	0	0	1	0	2	0
Monas,	0	0	1	0	0	0	0	6	0	0	0	0
Peridinium,	0	0	2	12	0	2	0	4	3	0	0	0
Trachelomonas,	0	0	0	0	2	2	0	0	2	4	4	2
Uroglena,	0	0	0	0	0	20	0	0	0	0	0	2
Vorticella,	0	0	0	0	8	0	0	0	0	0	0	0
Vermes,	0	[illegible]	2	[illegible]	0	0	0	0	0	[illegible]	0	0
Asplanchna,	0	0	2	2	0	0	0	0	0	0	0	0
Rotifer,	0	0	0	0	0	0	0	0	0	2	0	0
Crustacea, Cyclops,	0	0	0	.02	0	0	.02	0	0	.02	0	[illegible]
Miscellaneous,	40	[illegible]	10	.06	40	20	5	60	240	80	[illegible]	[illegible]
Acarina,	0	0	.02	.06	0	0	0	0	.10	.02	0	0
Zoöglœa,	40	10	10	0	40	20	5	60	240	80	120	60
TOTAL,	7,465	12	144	354	328	294	73	294	930	865	1,518	105

WINCHESTER.

Chemical Examination of Water from the South Reservoir of the Winchester Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15848	Jan. 7	Distinct.	Slight.	.18	4.15	1.80	.0004	.0296	.0278	.0018	.37	.0030	.0000	.40	1.8
16018	Feb. 4	Slight.	Slight.	.12	4.45	2.25	.0016	.0240	.0218	.0022	.38	.0000	.0000	.41	1.4
16183	Mar. 3	Slight.	Slight, green.	.18	4.05	1.90	.0000	.0298	.0252	.0046	.28	.0020	.0000	.35	1.6
16366	Apr. 7	Distinct, green.	Slight, green	.25	4.10	1.45	.0024	.0324	.0234	.0090	.32	.0000	.0001	.39	1.8
16541	May 5	Decided	Cons., green.	.25	3.75	1.40	.0000	.0326	.0220	.0106	.40	.0020	.0000	.41	1.4
16713	June 2	Decided.	Slight, green.	.22	4.40	1.55	.0002	.0308	.0226	.0082	.31	.0000	.0000	.43	1.9
16927	July 7	Distinct.	Cons., green	.20	4.10	1.70	.0004	.0354	.0296	.0058	.35	.0050	.0000	.49	1.4
17123	Aug. 4	Decided	Cons.	.12	4 45	1.70	.0000	.0286	.0232	.0054	.43	.0030	.0000	.52	1.6
17351	Sept. 2	Decided.	Slight.	.15	4.85	1.90	.0004	.0510	.0330	.0180	.40	.0000	.0002	.52	1.7
17585	Oct. 6	Distinct.	Slight.	.12	4.25	1.75	.0012	.0438	.0324	.0114	.40	.0000	.0000	.51	1.6
17778	Nov. 3	Distinct, green	Slight, brown.	.27	4.60	2.00	.0254	.0282	.0248	.0034	.38	.0080	.0001	.34	1.6
17986	Dec. 2	Distinct.	Slight.	.12	3.46	1.65	.0166	.0254	.0210	.0044	.40	.0200	.0001	.35	1.7

Averages by Years.

-	1891*	-	-	.60	5.78	2.09	.0110	.0486	.0361	.0125	.40	.0094	.0006	-	2.3
-	1892	-	-	.51	5.17	2.04	.0055	.0392	.0318	.0074	.39	.0118	.0002	-	2.2
-	1893	-	-	.34	4.78	1.86	.0064	.0291	.0216	.0075	.38	.0093	.0002	.49	2.1
-	1894	-	-	.18	4.56	1.76	.0049	.0267	.0232	.0035	.41	.0024	.0001	.45	1.9
-	[redacted]	-	-	.18	4.44	1.77	.0039	.0261	.0226	.0035	.41	.0070	.0001	.41	1.9
-	1896	-	-	.18	4.22	1.75	.0040	.0326	.0256	.0070	.37	.0036	.0000	.43	1.6

* August to December.

Note to analyses of 1896 Odor, generally distinctly vegetable, occasionally unpleasant; in June, faintly fishy and oily. On heating, the odor of Nos. 16366 and 16541 became fishy. —— The samples were collected from the reservoir, near the gate house.

WINCHESTER.

Microscopical Examination of Water from the South Reservoir of the Winchester Water Works.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	[illegible]	Mar.	Apr.	May.	June.	July.	Aug	Sept	Oct.	Nov	Dec.
Day of examination,	8	6	4	8	6	3	7	5	2	6	4	3
Number of sample,	15848	16013	16163	16366	16541	16712	16927	17123	17351	17565	17776	17968
PLANTS.												
Diatomaceæ,	1,290	10	73	10	14	60	8	15	56	48	6	104
Asterionella,	1,284	0	64	0	0	5	0	4	36	40	0	64
Cyclotella,	1	0	0	0	0	0	0	0	0	8	6	8
Navicula,	0	0	1	0	8	0	8	0	0	0	0	0
Nitzschia,	0	0	0	0	0	0	0	0	0	0	0	24
Synedra,	1	1	8	4	8	5	0	8	12	0	0	8
Tabellaria,	4	0	0	6	6	50	0	3	8	0	0	0
Cyanophyceæ,	[illegible]	0	0	0	0	0	80	215	3,212	400	0	0
Anabæna,	0	0	0	0	0	0	78	212	3,200	400	0	0
Clathrocystis,	0	0	0	0	0	0	2	0	4	0	0	0
Microcystis,	0	0	0	0	0	0	0	3	8	0	0	0
Algæ,	[illegible]	[illegible]	194	45	401	1	30	[illegible]	140	228	40	64
Protococcus,	0	0	0	1	0	0	10	0	96	10	0	0
Raphidium,	0	0	0	4	400	1	10	88	44	216	40	48
Scenedesmus,	5	0	2	40	1	0	0	0	0	2	0	0
Selenastrum,	6	0	0	0	0	0	0	0	0	0	0	0
Zoöspores,	24	0	192	0	0	0	10	0	0	0	0	16
ANIMALS.												
Infusoria,	0	0	0	458	8	pr.	6	7	4	8	18	6
Ciliated infusorian,	0	0	0	0	5	0	0	0	0	0	0	0
Cryptomonas,	0	0	0	4	0	0	0	0	0	0	0	0
Dinobryon,	0	0	0	50	0	0	0	0	0	0	0	0
Monas,	0	0	0	400	0	0	6	0	0	2	0	0
Peridinium,	0	0	0	1	0	0	0	6	0	0	0	2
Trachelomonas,	0	0	0	0	8	0	0	1	4	6	18	4
Uroglena,	0	0	0	3	0	pr.	0	0	0	0	0	0
Vermes,	0	0	1	0	4	11	0	0	12	2	6	0
Anuræa,	0	0	1	0	1	9	0	0	8	2	4	0
Polyarthra,	0	0	0	0	0	1	0	0	0	0	2	0
Rotatorian ova,	0	0	0	0	1	1	0	0	0	0	0	0
Rotifer,	0	0	0	0	2	0	0	0	4	0	0	0
Crustacea, Cyclops,	0	0	0	0	0	0	0	0	0	0	.02	.01
Miscellaneous,	20	0	10	100	10	60	.21	60	120	100	140	100
Acarina,	0	0	0	0	0	0	.21	.02	0	.04	0	0
Zoöglœa,	20	0	10	100	10	60	0	60	120	100	140	100
TOTAL,	1,345	10	275	621	437	132	126	356	3,544	786	210	274

WINCHESTER.

Chemical Examination of Water from the Middle Reservoir of the Winchester Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
15847	Jan. 7	Decided.	Slight.	.35	4.10	2.35	[redacted]	.0586	.0510	.0076	.40	.0070	.0001	.68	1.3
16012	Feb. 4	Distinct.	Slight.	[redacted]	4.45	2.65	.0004	.0450	.0368	.0082	[redacted]	.0030	.0001	.63	1.0
16164	Mar. 3	Decided, green.	Slight, green.	.33	3.60	1.60	.0000	.0466	.0352	.0114	.27	.0030	.0000	.54	1.1
16365	Apr. 7	Decided, green.	Slight, green.	.30	4.15	1.65	.0000	.0470	.0296	.0174	.32	.0050	.0000	.55	1.4
16540	May 5	Decided.	Cons., green.	.30	4.45	2.30	.0002	.0488	.0304	[redacted]	.36	.0050	.0000	.60	1.2
16712	June 2	Thick, green.	Cons.	.40	4.50	2.35	.0000	.0594	.0330	.0264	.31	[redacted]	.0000	.68	1.6
16926	July 7	Decided, green.	Slight, green.	.43	4.60	2.30	[redacted]	.0526	.0364	.0162	.35	.0030	.0000	.75	1.4
17147	Aug. 7	Decided, green.	Cons., green.	.47	5.10	2.60	.0008	.0536	.0330	.0206	.40	.0030	.0000	.76	1.7
17330	Sept. 2	Decided	Slight.	.70	5.45	[redacted]	.0008	.0690	.0390	.0300	.38	.0030	.0001	.91	1.6
17584	Oct. 5	Distinct.	Slight.	.38	4.60	2.20	.0012	.0658	[redacted]	.0128	[redacted]	.0030	.0000	.77	1.4
17777	Nov. 3	Decided, green.	Slight, green.	.60	4.70	2.65	.0004	.0490	.0342	.0148	[redacted]	.0100	.0001	.72	1.1
17987	Dec. 2	Distinct.	Slight.	.50	3.70	2.15	.0010	.0434	.0376	.0058	[redacted]	.0180	.0000	.71	0.9

Averages by Years.

-	1894*	-	-	.79	5.48	3.02	.0045	.0723	.0485	.0238	.44	.0032	.0001	.86	1.5
-	1895	-	-	.41	4.54	2.58	.0054	.0693	.0462	.0231	.41	.0063	.0001	.70	1.3
-	1896	-	-	.41	4.45	2.28	.0004	.0524	.0373	.0151	.36	.0058	.0000	.69	1.3

* May to December.

Note to analyses of 1896: Odor, generally distinctly vegetable, sometimes unpleasant, frequently becoming grassy or mouldy on heating. In June the odor was decidedly fishy and oily.—— The samples were collected from the reservoir, near the dam.

WINCHESTER.

Microscopical Examination of Water from the Middle Reservoir of the Winchester Water Works.

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb	Mar.	Apr.	May.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	8	5	4	8	6	3	7	7	2	6	4	3
Number of sample,	15847	16012	16184	16365	16540	16712	16926	17147	17350	17564	17777	17967
PLANTS.												
Diatomaceæ,	124	76	8	80	808	1,360	1,680	22	728	4	236	40
Asterionella,	0	0	0	70	800	1,200	0	0	0	0	4	0
Cyclotella,	0	0	2	0	0	0	176	0	0	0	0	8
Fragilaria,	0	0	0	0	0	0	1,504	0	0	0	0	0
Navicula,	0	0	0	0	2	0	0	2	0	4	0	0
Nitzschia,	0	0	0	0	0	0	0	20	720	0	0	8
Synedra,	116	76	6	10	6	160	0	0	8	0	232	0
Tabellaria,	8	0	0	0	0	0	0	0	0	0	0	24
Cyanophyceæ,	0	0	0	0	0	17	20	15	24	2	0	0
Anabæna,	0	0	0	0	0	17	16	15	8	2	0	0
Microcystis,	0	0	0	0	0	0	4	0	16	0	0	0
Algæ,	1,510	460	4,014	1,216	1,650	6,600	316	133	192	126	1,000	56
Cœlastrum,	0	0	0	2	0	0	0	1	8	0	0	0
Protococcus,	1,320	448	4,000	0	0	0	20	0	0	0	33	4
Raphidium,	41	2	2	14	33	1,600	40	80	16	48	500	4
Scenedesmus,	118	10	6	1,200	1,600	5,000	256	32	136	76	466	12
Selenastrum,	26	0	0	0	15	0	0	0	0	0	0	0
Staurastrum,	5	0	2	0	2	0	0	20	32	2	0	0
Zoöspores,	0	0	4	0	0	0	0	0	0	0	0	36
Fungi, Leptothrix,	0	0	0	0	0	0	0	800	800	0	0	0
ANIMALS.												
Infusoria,	38	148	200	258	159	285	8	178	536	342	42	20
Cryptomonas,	0	0	0	0	0	0	2	60	0	0	2	3
Dinobryon,	0	0	24	74	65	0	0	0	0	0	0	0
Euglena,	1	0	6	24	4	0	0	2	4	0	0	0
Mallomonas,	1	0	4	2	1	0	0	0	4	2	0	0
Monas,	0	0	0	60	0	0	2	40	0	0	0	0
Peridinium,	36	148	108	52	1	160	0	20	4	0	30	0
Phacus,	0	0	0	0	0	0	0	0	12	0	0	1
Synura,	0	0	40	2	0	0	0	0	[illegible]	0	0	0
Raphidomonas,	0	0	0	0	0	0	0	0	216	140	0	0
Trachelomonas,	0	0	14	44	6	100	4	56	296	200	10	16
Uroglena,	0	0	2	0	82	25	0	0	[illegible]	0	0	0
Vermes,	2	0	2	2	22	4	8	2	20	4	4	0
Anguillula,	0	0	0	0	0	0	8	0	0	0	0	0
Anuræa,	1	0	0	0	12	1	0	2	8	2	4	0
Asplanchna,	0	0	2	0	2	0	0	0	[illegible]	0	0	0
Polyarthra,	0	0	0	0	4	0	0	0	4	2	0	0
Rotatorian ova,	0	0	0	2	4	0	0	0	4	0	0	0
Rotifer,	1	0	0	0	0	3	0	0	4	0	0	0
Crustacea,	0	0	.02	.02	0	0	0	0	0	0	0	0
Cyclops,	0	0	.02	0	0	0	0	0	0	0	0	0
Daphnia,	0	0	0	.02	0	0	0	0	0	0	0	0
Miscellaneous,	40	0	0	60	100	100	10	80	160	90	60	40
Acarina,	.02	0	0	.04	0	0	0	.02	0	.02	0	0
Zooglœa,	40	0	0	60	100	100	10	80	160	90	60	40
TOTAL,	1,714	684	4,224	1,616	2,739	8,366	2,042	1,230	2,460	568	1,342	156

Water Supply of Winthrop.

(See *Revere.*)

Water Supply of Woburn.

The advice of the State Board of Health to the water commissioners of the city of Woburn, relative to the quality of the water supplied to the city, may be found on pages 48 and 49 of this volume.

Chemical Examination of Water from the Filter-gallery of the Woburn Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
15935	Jan. 22	None.	None.	.01	10.70	.0030	.0022	1.74	.0320	.0000	.04	5.0	.0010
16104	Feb. 19	None.	None.	.00	11.10	.0032	.0022	1.71	.0400	.0000	.02	4.5	.0000
16291	Mar. 18	None.	None.	.00	10.35	.0030	.0036	1.68	.0280	0000	.05	4.7	.0000
16443	Apr. 21	None.	None.	.00	10.65	.0028	.0032	1.58	.0270	.0000	.02	5.3	.0020
16631	May 20	None.	None.	.00	11.00	.0052	.0036	1.53	.0250	.0000	.08	5.0	.0020
16829	June 18	None.	None.	.02	10.10	.0028	.0022	1.52	.0220	.0000	.08	5.1	.0020
17020	July 20	None.	None.	.01	11.10	.0022	.0022	1.60	.0180	.0000	.02	5.1	.0030
17261	Aug 20	None.	None.	.01	10.50	.0032	.0050	1.49	.0180	.0000	.07	4.9	.0000
17435	Sept. 14	None.	None.	.01	10.35	.0056	.0026	1.48	.0100	.0000	.02	4.7	.0010
17690	Oct. 21	None.	None.	.01	9.70	.0032	.0040	1.50	.0180	.0000	.05	4.8	.0026
17897	Nov. 18	None.	Slight.	.00	10.25	.0038	.0038	1.54	.0290	.0000	.04	5.5	.0000
18146	Dec. 16	None.	None.	.00	10.10	.0058	.0026	1.49	.0250	.0000	.06	5.3	.0000

Averages by Years.

-	1887*	-	-	[illegible]	12.06	.0014	.0028	2.40	.0314	-	-	-	-
-	1888	-	-	.00	12.00	.0012	.0032	2.50	.0346	.0000	-	-	-
-	1889	-	-	.00	10.84	.0010	.0022	2.07	.0372	.0000	-	-	-
-	1890	-	-	.01	11.06	.0012	.0023	1.91	.0481	.0000	-	5.0	-
-	1891	-	-	.00	10.85	.0008	.0015	1.79	.0668	.0000	-	4.9	-
-	1892	-	-	.00	11.27	.0012	.0024	1.95	.0542	.0000	-	5.1	-
-	1893	-	-	.00	11.50	.0022	.0018	2.04	.0447	.0000	.05	5.3	.0004
-	1894	-	-	.01	11.02	.0026	.0018	1.94	.0262	.0000	.05	5.0	.0021
-	1895	-	-	.01	10.62	.0031	.0022	1.74	.0204	.0000	.06	4.9	.0023
-	1896	-	-	.01	10.49	.0033	.0031	1.56	.0242	[illegible]	.04	5.0	.0011

* June to December.

NOTE to analyses of 1896: Odor, none.—The samples were collected from the filter-gallery.

Microscopical Examination.

An insignificant number of organisms was found in No. 16291; no organisms were found in the remaining samples.

WOBURN.

Chemical Examination of Water from Horn Pond, Woburn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15934	Jan. 22	V. slight.	Slight.	.40	9.35	3.60	.0008	.0290	.0170	.0120	1.20	.1360	.0010	.48	3.1
16108	Feb. 19	Decided, green.	Slight.	.35	9.55	3.30	.0056	.0308	.0174	.0134	1.00	.1150	.0013	.42	2.6
16290	Mar. 16	Distinct.	Slight.	.37	7.55	2.70	.0102	.0200	.0170	.0030	0.95	.0760	.0009	.44	2.9
16442	Apr. 21	Distinct.	Cons., green.	.37	6.95	2.05	.0010	.0308	.0156	.0152	0.97	.0900	.0011	.34	2.7
16630	May 20	Distinct.	Cons., green.	.27	7.40	2.70	.0006	.0286	.0184	.0102	1.10	.0400	.0014	.36	2.8
16828	June 18	Decided, green.	Cons., green.	.27	7.60	2.10	.0010	.0286	.0196	.0090	1.15	.0600	.0025	.36	3.1
17019	July 20	Slight.	Slight.	.23	8.50	2.75	.0044	.0352	.0216	.0136	1.30	.0070	0090	.35	3.1
17260	Aug. 20	Distinct, green.	Slight, green	.20	8.70	2.00	.0000	.0378	.0230	.0148	1.27	.0050	.0000	.42	2.9
17434	Sept. 14	Decided.	Cons., green.	.20	8.45	1.80	.0000	.0426	.0222	.0204	1.26	.0000	.0000	.34	3.1
17689	Oct. 21	Distinct, green.	Slight.	.25	8.30	2.00	.0184	.0336	.0232	.0104	1.30	.0070	.0005	.38	[illegible]
17896	Nov. 18	Distinct, green.	Cons., green.	.20	8.40	2.00	.0068	.0366	.0232	.0134	1.30	.0180	.0008	.37	3.8
18145	Dec. 16	Distinct.	Slight.	.23	8.65	2.20	.0084	.0312	.0200	.0112	1.37	.0800	.0003	.43	3.9

Averages by Years.

-	1887*	-	-	.44	13.79	2.19	.0149	.0480	-	-	3.74	.0324	-	-	-
-	1888	-	-	.32	11.28	1.71	.0186	.0393	-	-	2.98	.0398	.0015	-	-
-	1889	-	-	.30	8.37	2.03	.0092	.0376	.0216	.0160	1.98	.0498	.0015	-	-
-	1890	-	-	.27	10.76	2.07	.0060	.0380	.0211	.0169	1.93	.0542	.0008	-	3.4
-	1891	-	-	.22	8.90	2.06	.0129	.0453	.0237	.0216	1.76	.0502	.0009	-	2.9
-	1892	-	-	.25	10.57	2.13	.0110	.0358	.0216	.0142	2.42	.0621	.0008	-	3.3
-	1893	-	-	.30	9.83	2.51	.0061	.0455	.0247	.0208	2.10	.0472	.0009	.65	3.2
-	1894	-	-	.33	9.03	1.98	.0065	.0292	.0184	.0108	1.84	.0404	.0009	.40	3.3
-	1895	-	-	.35	9.43	2.84	.0087	.0297	.0205	.0092	1.63	.0623	.0014	.48	3.4
-	1896	-	-	.27	8.27	2.43	.0043	.0321	.0199	.0122	1.18	.0476	.0010	.39	3.1

* June to December.

NOTE to analyses of 1896: Odor, distinctly vegetable. A sweet grassy or mouldy odor was developed in some of the samples on heating. — The samples were collected from the pond at its outlet, 1 foot beneath the surface.

WOBURN.

Microscopical Examination of Water from Horn Pond, Woburn.

[Number of organisms per cubic centimeter

	1896.											
	Jan	Feb.	Mar	Apr	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.
Day of examination,	23	21	20	22	21	19	21	21	14	22	19	14
Number of sample,	15934	16103	16290	16442	16630	16828	17019	17260	17434	17669	17896	18145
PLANTS.												
Diatomaceæ,	330	[redacted]	36	5,080	8,500	0	320	10	66	78	544	413
Asterionella,	192	18	30	5,000	8,000	0	0	0	0	0	348	72
Melosira,	9	16	3	0	0	0	0	0	0	76	84	296
Navicula,	1	0	0	0	0	0	0	0	2	2	8	1
Nitzschia,	0	0	0	0	0	0	0	0	0	0	8	0
Synedra,	128	32	3	64	500	0	320	10	64	0	52	44
Tabellaria,	0	0	0	16	0	0	0	0	0	0	44	0
Cyanophyceæ,	0	0	0	20	0	2	41	60	200	130	28	0
Anabæna,	0	0	0	0	0	0	2	0	154	128	26	0
Clathrocystis,	0	0	0	0	0	0	9	58	36	0	0	0
Cœlosphærium,	0	0	0	0	0	0	0	2	10	2	2	0
Microcystis,	0	0	0	0	0	2	30	0	0	0	0	0
Oscillaria,	0	0	0	20	0	0	0	0	0	0	0	0
Algæ,	19	26	21	0	4	272	585	8,872	444	262	40	13
Cosmarium,	0	0	0	0	0	10	88	0	184	204	4	1
Pediastrum,	0	0	0	0	0	76	2	8	6	0	0	0
Protococcus,	11	0	21	0	0	116	[illegible]	8,000	18	1	0	1
Raphidium,	0	0	0	0	0	0	0	0	0	1	0	7
Scenedesmus,	8	2	0	0	2	32	68	728	220	56	36	2
Staurastrum,	0	0	0	0	2	38	52	136	16	0	0	1
Zoöspores,	0	24	0	0	0	0	36	0	0	0	0	1
Fungi, Crenothrix,	0	0	0	0	0	0	0	0	0	0	70	0
ANIMALS												
Rhizopoda, Actinophrys,	0	0	0	[redacted]	0	0	0	0	[illegible]	0	0	0
Infusoria,	49	78	0	238	0	16	1	0	14	38	112	5
Ceratium,	0	0	0	0	0	0	0	0	8	0	0	0
Ciliated infusorian,	0	1	0	0	0	0	0	0	0	2	0	0
Cryptomonas,	41	72	0	236	0	0	0	0	0	0	28	0
Epistylis,	0	0	0	0	0	16	0	0	0	0	0	0
Monas,	1	5	0	2	0	0	1	0	0	0	12	1
Phacus,	0	0	0	0	0	0	0	0	4	0	0	0
Trachelomonas,	7	0	0	0	0	0	0	0	2	32	72	4
Vorticella,	0	0	0	0	0	0	0	0	0	2	0	0
Vermes,	0	0	0	0	1	0	1	0	8	0	0	0
Anurea,	0	0	0	0	1	0	0	0	2	0	0	0
Polyarthra,	0	0	0	0	0	0	1	0	2	0	0	0
Rotatorian ova,	0	0	0	0	0	0	0	0	2	0	0	0
Crustacea,	0	0	0	0	0	0	.18	0	0	0	0	0
Bosmina,	0	0	0	0	0	0	.16	0	0	0	0	0
Cyclops,	0	0	0	0	0	0	.02	0	0	0	0	0
Miscellaneous,	0	40	0	0	0	.02	.06	20	40	80	0	100
Acarina,	0	0	0	0	0	.02	.06	0	0	0	0	0
Zoöglœa,	0	40	0	0	0	0	0	20	40	60	0	100
TOTAL,	398	210	57	5,336	8,505	290	949	8,962	772	586	794	531

Water Supply of Worcester.

Leicester Supply. — *Chemical Examination of Water from Lynde Brook Storage Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
15921	Jan. 21	V. slight.	V. slight	.37	3.40	1.50	.0032	.0180	.0156	.0024	.21	.0100	.0000	.51	1.1
16063	Feb. 18	Slight.	Slight.	.37	3.10	1.35	.0032	.0142	.0124	.0018	.16	.0100	.0000	.49	0.6
16274	Mar. 17	Slight.	Slight.	.30	2.80	1.35	.0058	.0126	.0104	.0022	.17	.0100	.0000	.39	0.6
16459	Apr. 22	Slight, green.	Slight.	.26	2.45	0.75	.0010	.0126	.0092	.0034	.14	.0070	.0000	.42	0.8
16627	May 19	Slight	Slight.	.23	2.55	1.25	.0000	.0146	.0114	.0032	.19	.0060	.0000	.27	0.6
16809	June 16	Distinct.	Slight.	.20	3.00	1.05	.0002	.0148	.0118	.0030	.11	.0020	.0000	.30	0.7
17033	July 21	Slight.	Slight.	.20	2.65	1.35	.0000	.0162	.0152	.0010	.14	.0030	.0000	.34	0.6
17238	Aug 18	Slight.	Slight.	.17	2.55	1.20	.0000	.0158	.0140	.0018	.16	.0020	.0000	.37	0.6
17459	Sept. 14	Slight.	Cons.	.20	2.85	1.00	.0004	.0172	.0138	.0034	.17	.0020	.0000	.34	0.9
17653	Oct. 20	Slight.	Slight.	.33	3.05	1.40	.0102	.0176	.0148	.0028	.20	.0030	.0000	.41	0.9
17886	Nov. 17	Slight.	Slight.	.40	3.70	1.75	.0108	.0202	.0178	.0024	.26	.0050	.0001	.41	1.4
18132	Dec. 15	Distinct.	Slight.	.38	3.30	1.25	.0068	.0154	.0134	.0020	.25	.0030	.0001	.44	0.9

Averages by Years.

-	1887*	-	-	.30	3.15	0.95	.0067	.0194	-	-	.15	.0043	-	-	-
-	1888	-	-	.24	2.64	0.85	.0037	.0151	-	-	.14	.0065	.0001	-	-
-	1889	-	-	.24	2.64	0.90	.0030	.0167	.0138	.0029	.15	.0053	.0001	-	-
-	1890	-	-	.21	3.07	1.15	.0026	.0132	.0107	.0025	.14	.0078	.0001	-	0.9
-	1891	-	-	.24	2.83	1.05	.0045	.0136	.0101	.0035	.12	.0074	.0001	-	0.7
-	1892	-	-	.25	[illegible]	1.15	.0038	.0139	.0113	.0026	.15	.0105	.0000	-	0.8
-	1893	-	-	.26	2.66	0.98	.0066	.0162	.0122	.0039	.15	.0066	.0001	.35	0.6
-	1894	-	-	[illegible]	3.37	1.09	.0055	.0139	.0117	.0022	.18	.0108	.0000	.35	1.2
-	1895	-	-	.32	3.63	1.30	.0033	.0161	.0136	.0025	.20	.0116	.0000	.45	1.2
-	1896	-	-	.29	2.95	1.27	.0035	.0158	.0133	.0025	.18	.0054	.0000	.38	0.8

* June to December.

Note to analyses of 1896: Odor, generally distinctly vegetable. On heating, the odor became stronger and also grassy or mouldy. —— The samples were collected from the reservoir near the gate-house, about 1 foot beneath the surface.

For record of heights of water in this reservoir, see page 384.

WORCESTER.

LEICESTER SUPPLY.—***Microscopical Examination of Water from Lynde Brook Storage Reservoir.***

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	22	19	19	23	21	15	22	20	16	22	19	17
Number of sample,	15921	16063	16274	16459	16627	16809	17033	17239	17450	17682	17886	18122
PLANTS.												
Diatomaceæ,	44	0	22	38	11	166	0	[illegible]	3	62	[illegible]	30
Asterionella,	40	0	17	20	2	31	0	0	0	38	224	20
Cyclotella,	0	0	0	0	0	112	0	0	2	0	22	6
Melosira,	0	0	0	0	0	0	0	0	0	22	125	0
Stephanodiscus,	0	0	0	0	4	0	0	0	0	2	0	0
Synedra,	2	0	2	8	3	20	0	0	1	0	2	0
Tabellaria,	2	0	3	10	2	3	0	0	0	0	18	4
Cyanophyceæ,	0	0	0	0	5	60	24	148	272	94	0	0
Anabæna,	0	0	0	0	5	50	0	4	20	0	0	0
Chroöcoccus,	0	0	0	0	0	0	24	124	244	18	0	0
Merismopedia,	0	0	0	0	0	0	0	0	6	0	0	0
Microcystis,	0	0	0	0	0	1	0	20	2	76	0	0
Algæ,	4	0	0	2	124	227	5	0	[illegible]	20	36	0
Cosmarium,	0	0	0	0	0	3	1	0	6	0	0	0
Protococcus,	2	0	0	2	120	148	0	0	0	[illegible]	0	0
Raphidium,	2	0	0	0	4	0	4	0	4	2	8	0
Staurogenia,	0	0	0	0	0	76	0	0	0	12	28	0
ANIMALS.												
Infusoria,	7	58	22	42	116	0	[illegible]	[illegible]	0	0	2	6
Dinobryon,	6	58	12	36	116	0	0	0	0	0	0	0
Dinobryon cases,	0	0	8	0	0	0	0	0	0	0	0	0
Peridinium,	0	0	2	4	0	0	0	0	0	0	0	4
Tintinnidium,	0	0	0	0	0	0	0	0	0	0	0	2
Trachelomonas,	1	0	0	2	0	0	0	0	0	0	2	0
Vermes, Polyarthra,	0	0	0	0	0	0	[illegible]	1	1	0	0	0
Miscellaneous,	0	[illegible]	5	20	0	0	.02	20	20	35	60	30
Acarina,	0	0	0	0	0	0	.02	0	0	0	0	0
Zoöglœa,	0	20	5	20	0	0	0	20	20	35	60	30
TOTAL,	55	78	49	102	256	453	29	170	306	211	482	66

WORCESTER.

LEICESTER SUPPLY. — *Chemical Examination of Water from Kent Reservoir on Kettle Brook in Leicester.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
18134	Dec. 15	Distinct, clayey.	Cons., earthy.	.29	3.20	1.15	.0018	.0154	.0134	.0020	.22	.0100	.0000	.45	1.5

Odor, faintly vegetable. —— The sample was collected from the reservoir at the gate-house, 1 foot beneath the surface.

Microscopical Examination.

The total number of organisms per cubic centimeter found in this sample was 168.

LEICESTER SUPPLY. — *Chemical Examination of Water from Mann Reservoir on Kettle Brook, Leicester.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15922	Jan. 21	V. slight.	V. slight.	.70	3.30	1.70	.0152	.0214	.0182	.0032	.14	.0180	.0001	.71	1.0
16082	Feb. 18	Slight.	Slight.	.40	3.45	1.55	.0082	.0144	.0120	.0024	.10	.0170	.0000	.50	0.9
16273	Mar. 17	Slight.	Slight.	.40	3.15	1.35	.0082	.0132	.0108	.0024	.16	.0050	.0001	.50	1.1
16458	Apr. 21	Slight, green.	Slight.	.30	2.30	0.95	.0014	.0126	.0112	.0014	.10	[illegible]	.0000	.45	0.8
16626	May 19	Distinct	Slight.	.33	2.45	1.00	.0004	.0176	.0130	.0046	.16	.0070	.0000	.34	0.5
16810	June 16	Distinct.	Cons., yellow	.30	3.00	1.05	.0024	.0216	.0182	.0034	.08	.0020	.0000	.35	0.5
17034	July 21	Distinct.	Cons.	[illegible]	2.95	1.65	.0016	.0314	.0200	.0114	.12	.0030	.0000	.41	0.8
17239	Aug. 18	Distinct	Cons., green	.30	3.55	1.65	.0006	.0240	.0204	.0036	.13	.0000	.0000	.50	1.1
17460	Sept. 14	Distinct.	Cons., green.	.25	3.10	1.30	.0028	.0266	.0192	.0074	.15	.0030	.0000	.55	0.9
17684	Oct. 20	Slight.	Slight.	.30	3.40	1.55	.0038	.0210	.0168	.0042	.21	.0030	.0000	.55	1.1
17887	Nov. 17	Distinct	Slight.	.35	3.45	1.70	.0000	.0196	.0168	.0028	.21	.0050	.0001	.50	0.9
Av....	1896	....	....	.36	3.15	1.39	.0041	.0203	.0161	.0042	.14	.0075	.0000	.50	0.9
Av...	1895	....	....	.50	3.56	1.67	.0054	.0234	.0187	.0047	.18	.0087	.0000	.60	1.0

NOTE to analyses of 1896. Odor, generally distinctly vegetable, becoming somewhat stronger and also sweet grassy on heating. —— The samples were collected from the reservoir near the dam, 1 foot beneath the surface.

WORCESTER.

Leicester Supply. — ***Microscopical Examination of Water from Mann Reservoir on Kettle Brook, Leicester.***

[Number of organisms per cubic centimeter.]

	1896.										
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept	Oct.	Nov.
Day of examination,	22	19	19	23	21	18	22	20	16	22	19
Number of sample,	15923	16082	16273	16468	16626	16810	17034	17239	17460	17684	17887
PLANTS.											
Diatomaceæ,	4	0	16	126	112	175	231	894	460	324	208
Asterionella,	4	0	2	23	0	0	2	0	0	228	150
Cyclotella,	0	0	3	0	2	5	0	84	2	0	6
Cymbella,	0	0	0	0	2	0	0	4	0	0	0
Melosira,	0	0	3	0	56	160	224	500	50	64	43
Meridion,	0	0	1	0	2	1	0	2	0	0	0
Navicula,	0	0	1	0	6	3	1	20	0	8	2
Surirella,	0	0	0	0	0	0	2	4	0	0	2
Synedra,	0	0	2	3	24	1	0	280	428	20	2
Tabellaria,	0	0	4	100	20	5	2	0	0	4	4
Cyanophyceæ,	0	0	0	0	0	0	0	0	38	0	0
Anabæna,	0	0	0	0	0	0	0	0	24	0	0
Chroöcoccus,	0	0	0	0	0	0	0	0	14	0	0
Algæ,	0	0	0	0	30	22	35	[illegible]	24	0	0
Protococcus,	0	0	0	0	6	20	11	40	0	0	0
Raphidium,	0	0	0	0	12	2	0	6	18	0	0
Scenedesmus,	0	0	0	0	8	0	20	6	6	0	0
Staurastrum,	0	0	0	0	2	0	4	8	0	0	0
Staurogenia,	0	0	0	0	[illegible]	0	0	0	0	0	0
ANIMALS.											
Infusoria,	25	0	0	5	2	1	433	52	[illegible]	112	34
Cryptomonas,	0	0	0	0	0	0	0	0	0	0	2
Dinobryon,	25	0	0	2	0	0	404	24	268	112	22
Mallomonas,	0	0	0	1	0	0	0	2	2	0	0
Monas,	0	0	0	0	0	1	0	0	0	0	6
Peridinium,	0	0	0	0	2	0	20	20	0	0	2
Tintinnidium,	0	0	0	2	0	0	7	0	0	0	0
Trachelomonas,	0	0	0	0	0	0	2	6	0	0	0
Uroglena,	0	0	0	0	0	0	0	0	0	0	2
Vermes,	0	0	0	0	0	0	8	2	0	4	0
Anuræa,	0	0	0	0	0	0	2	0	0	0	0
Asplanchna,	0	0	0	0	0	0	0	0	0	4	0
Polyarthra,	0	0	0	0	0	0	5	0	0	0	0
Rotifer,	0	0	0	0	0	0	1	2	0	0	0
Crustacea,	0	0	0	0	0	.02	.02	0	0	0	[illegible]
Cyclops,	0	0	0	0	0	.02	0	0	0	0	.08
Entomostracan ova,	0	0	0	0	0	0	.02	0	0	0	0
Miscellaneous,	0	[illegible]	5	40	0	60	.10	60	40	40	20
Acarina,	0	0	0	0	0	0	.10	.04	0	0	.04
Zoöglœa,	0	5	5	40	0	60	0	60	40	40	20
Total,	32	5	21	171	130	258	707	1,066	852	480	265

WORCESTER.

LEICESTER SUPPLY. — *Chemical Examination of Water from Bottomly Pond on Kettle Brook, Paxton.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15924	Jan. 21	V. slight.	Slight.	.90	3.90	1.95	.0304	.0264	.0230	.0034	.14	.0140	.0001	.78	1.3
16061	Feb. 18	V. slight.	V. slight.	.66	3.60	1.75	.0138	.0164	.0156	.0008	.13	.0150	.0000	.59	0.9
16272	Mar. 17	Slight.	Slight.	.33	2.05	1.25	.0092	.0152	.0136	.0016	.11	.0150	.0000	.47	0.6
16456	Apr. 21	Slight.	Slight.	.30	2.20	0.75	.0034	.0158	.0120	.0038	.11	.0150	.0000	.44	0.5
16629	May 19	Distinct.	Slight.	.35	2.40	1.35	.0000	.0162	.0134	.0028	.16	.0070	.0000	.39	0.5
16811	June 16	Distinct.	Slight.	.22	2.60	1.10	.0014	.0244	.0190	.0054	.14	.0000	.0000	.38	0.6
17035	July 21	Slight.	Slight.	.25	2.65	1.40	.0000	.0182	.0150	.0032	.10	.0000	.0000	.39	0.3
17240	Aug. 18	Slight.	Slight.	.27	2.80	1.65	.0008	.0228	.0196	.0032	.14	.0000	.0000	.50	0.6
17461	Sept. 14	Distinct.	Cons., yellow.	.22	2.80	1.25	.0000	.0202	.0180	.0022	.15	.0020	.0000	.44	0.6
17686	Oct. 20	Slight.	Slight.	.30	3.20	1.50	.0002	.0206	.0178	.0028	.17	.0030	.0000	.52	0.7
17888	Nov. 17	Distinct.	Slight.	.33	3.45	1.85	.0008	.0238	.0218	.0020	.20	.0030	.0001	.54	0.9
18133	Dec. 15	Distinct.	Slight.	.33	3.15	1.35	.0008	.0194	.0134	.0060	.18	.0070	.0000	.53	1.0
Av....	1896	....	....	.37	2.89	1.43	.0042	.0199	.0168	.0031	.14	.0070	.0000	.50	0.7
Av....	1895	....	....	.46	3.51	1.84	.0056	.0259	.0223	.0036	.17	.0057	.0001	.64	1.0

NOTE to analyses of 1896: Odor, vegetable. —— The samples were collected from the reservoir near the dam, 1 foot beneath the surface.

WORCESTER.

LEICESTER SUPPLY. — *Microscopical Examination of Water from Bottomly Pond on Kettle Brook, Paxton.*

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.
Day of examination,	22	19	18	23	21	18	22	19	16	22	19	17
Number of sample,	15924	16061	16272	16456	16629	16811	17036	17240	17461	17685	17886	18123
PLANTS.												
Diatomaceæ,	0	0	8	6	23	38	31	41	386	24	94	12
Asterionella,	0	0	7	0	15	16	30	0	256	18	76	8
Cyclotella,	0	0	1	0	0	19	0	40	12	0	8	2
Navicula,	0	0	0	0	0	0	0	1	2	0	4	0
Synedra,	0	0	0	2	3	2	0	0	116	6	2	2
Tabellaria,	0	0	0	4	4	1	1	0	0	0	4	0
Cyanophyceæ, Anabæna,	0	0	0	0	[illegible]	0	1	0	0	0	0	0
Algæ,	0	0	0	2	192	8	216	[illegible]	24	0	0	2
Protococcus,	0	0	0	2	184	0	216	28	0	0	0	2
Raphidium,	0	0	0	0	8	0	0	2	24	0	0	0
Zoöspores,	0	0	0	0	0	8	0	0	0	0	0	0
ANIMALS.												
Infusoria,	27	2	36	438	6	[illegible]	55	10	2	2	62	16
Ciliated infusorian,	0	0	0	2	0	0	0	0	0	0	0	0
Cryptomonas,	0	0	0	0	0	0	0	0	0	0	0	2
Dinobryon,	0	0	35	428	0	0	35	1	2	2	56	12
Mallomonas,	0	0	1	2	0	0	0	0	0	0	0	0
Peridinium,	27	2	0	4	1	0	20	7	0	0	4	2
Synura,	0	0	0	0	0	0	0	0	0	0	2	0
Trachelomonas,	0	0	0	2	0	0	0	2	0	0	0	0
Vorticella,	0	0	0	0	5	0	0	0	0	0	0	0
Vermes,	2	0	0	2	0	0	2	2	0	2	2	2
Anuræa,	0	0	0	0	0	0	0	2	0	0	0	2
Asplanchna,	2	0	0	0	0	0	0	0	0	2	0	0
Polyarthra,	0	0	0	2	0	0	2	0	0	0	2	0
Crustacea, Cyclops,	0	0	0	0	0	0	0	0	0	[illegible]	.06	0
Miscellaneous, Zooglœa,	0	0	0	20	0	60	0	10	20	[illegible]	60	35
TOTAL,	29	2	53	468	206	101	306	93	432	528	218	67

WORCESTER.

HOLDEN SUPPLY. — *Chemical Examination of Water from Tatnuck Brook Storage Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15932	Jan 21	V. slight.	V. slight.	.26	2.45	1.10	.0000	.0112	.0098	.0014	.16	.0070	[illegible]	.30	0.6
16064	Feb. 18	Slight.	Slight.	.25	2.30	1.05	.0000	.0104	.0096	.0008	.11	.0050	.0000	.32	0.6
16271	Mar. 17	V. slight.	V. slight.	.20	1.45	0.65	.0012	.0094	.0074	.0020	.14	.0070	.0000	.33	0.3
16460	Apr. 22	Slight, green.	Slight.	.17	1.55	0.60	.0002	.0122	.0076	.0046	.10	.0050	.0000	.24	0.5
16628	May 19	Slight.	Slight.	.18	1.70	0.75	.0006	.0120	.0100	.0020	.16	.0030	.0000	.19	0.3
16808	June 16	Distinct.	Slight.	.16	2.15	0.65	.0008	.0122	.0100	.0022	.11	[illegible]	[illegible]	.22	0.2
17032	July 21	Slight.	Slight.	.12	1.50	0.70	.0000	.0148	.0118	.0030	.14	.0000	.0000	.20	[illegible]
17237	Aug 18	Distinct.	Slight.	.10	2.00	0.90	.0000	.0150	.0108	.0042	.16	[illegible]	.0000	.27	0.5
17458	Sept. 14	Distinct.	Cons.	.20	1.85	0.45	.0014	.0192	.0156	.0036	.17	.0000	.0000	.21	0.3
17653	Oct. 20	Slight.	Slight.	.12	1.75	0.75	.0010	.0190	.0108	.0082	.16	.0030	.0001	.25	0.3
17885	Nov. 17	Distinct.	Slight.	.12	2.45	1.20	.0034	.0212	.0166	.0046	.20	.0020	.0001	.32	0.3
18131	Dec. 15	Slight.	Slight.	.15	2.25	1.05	.0008	.0142	.0110	.0032	.21	.0030	.0000	.29	0.5

Averages by Years.

-	1887*	-	-	.29	2.62	1.01	.0007	.0197	-	-	.14	.0010	-	-	-
-	1888	-	-	.17	2.23	0.75	.0012	.0157	-	-	.12	.0043	.0001	-	-
-	1889	-	-	.19	2.04	0.57	.0003	.0148	.0112	.0031	.12	.0031	.0001	-	-
-	1890	-	-	.17	2.68	1.24	.0007	.0141	.0102	.0039	.13	.0078	.0001	-	0.9
-	1891	-	-	.17	2.30	0.94	.0024	.0143	.0102	.0041	.11	.0077	.0001	-	0.4
-	1892	-	-	.20	2.62	1.03	.0012	.0147	.0118	.0029	.12	.0067	.0000	-	0.5
-	1893	-	-	.35	2.45	0.93	.0020	.0182	.0140	.0042	.14	.0049	.0000	.36	0.5
-	1894	-	-	.20	2.27	0.86	.0010	.0151	.0114	.0037	.16	.0032	.0000	.30	0.4
-	1895	-	-	.21	2.33	0.98	.0012	.0173	.0130	.0043	.18	.0068	.0000	.36	0.5
-	1896	-	-	.17	2.00	0.84	.0008	.0142	.0109	.0033	.15	.0034	.0000	.27	0.4

* June to December.

NOTE to analyses of 1896: Odor, generally faintly vegetable, frequently stronger on heating. — The samples were collected from the reservoir at the gate house, 1 foot beneath the surface.

For record of heights of water in this reservoir, see page 364.

WORCESTER.

HOLDEN SUPPLY.—*Microscopical Examination of Water from Tatnuck Brook Storage Reservoir.*

[Number of organisms per cubic centimeter.]

	1896.											
	Jan.	Feb.	Mar.	Apr	May.	June.	July.	Aug	Sept.	Oct.	Nov.	Dec.
Day of examination,	22	19	18	28	21	18	22	20	15	22	19	17
Number of sample,	15922	16064	16271	16460	16628	16808	17032	17237	17458	17682	17885	18131
PLANTS.												
Diatomaceæ,	14	49	57	124	311	368	923	72	290	685	456	78
Asterionella,	11	28	2	18	9	48	63	0	11	185	2	6
Cyclotella,	0	0	0	0	0	0	0	0	13	0	0	0
Diatoma,	0	0	0	0	0	0	0	0	10	0	0	0
Fragilaria,	0	0	9	0	0	0	0	0	0	0	0	0
Melosira,	0	0	27	56	216	40	0	0	226	224	392	42
Synedra,	3	3	4	2	2	48	0	2	8	1	2	2
Tabellaria,	0	18	15	48	84	232	860	70	22	272	60	22
Cyanophyceæ, Anabæna,	0	0	[illegible]	0	0	0	1	4	0	[illegible]	0	2
Algæ,	0	0	0	0	0	4	0	5	2	1	26	38
Chlorococcus,	0	0	0	0	0	0	0	0	0	0	0	16
Desmidium,	0	0	0	0	0	0	0	0	0	0	20	18
Scenedesmus,	0	0	0	0	0	4	0	0	1	1	6	4
Staurastrum,	0	0	0	0	0	0	0	5	1	0	0	0
ANIMALS.												
Rhizopoda,	0	5	0	0	2	2	0	[illegible]	1	1	0	0
Actinophrys,	0	0	0	0	0	2	0	0	1	1	0	0
Arcella,	0	0	0	0	2	0	0	0	0	0	0	0
Difflugia,	0	5	0	0	0	0	0	0	0	0	0	0
Infusoria,	38	2	5	40	5	[illegible]	3	20	17	2	2	[illegible]
Dinobryon,	0	0	0	0	0	0	3	0	0	1	0	6
Codonella,	0	0	0	0	0	3	0	0	0	0	2	0
Euglena,	1	2	2	4	0	0	0	0	0	0	0	0
Mallomonas,	0	0	0	0	0	2	0	6	0	0	0	0
Peridinium,	34	0	3	32	3	0	0	10	10	0	0	2
Synura,	1	0	0	4	0	0	0	0	0	0	0	0
Trachelomonas,	2	0	0	0	2	1	0	4	6	0	0	2
Vorticella,	0	0	0	0	0	0	0	0	1	1	0	0
Vermes,	0	0	0	2	2	0	0	0	1	1	3	0
Anuræa,	0	0	0	2	2	0	0	0	1	1	1	0
Asplanchna,	0	0	0	0	0	0	0	0	0	0	2	0
Crustacea, Cyclops,	0	0	0	0	0	.02	0	0	0	0	0	0
Miscellaneous,	0	0	20	40	10	40	.02	20	80	40	20	20
Acarina,	0	0	0	0	0	0	.02	0	0	0	0	0
Zoöglœa,	0	0	20	40	10	40	0	20	80	40	20	20
TOTAL,	62	56	62	206	330	420	927	122	391	730	507	150

WORCESTER.

Record of Height of Water in Leicester and Holden Storage Reservoirs on the First of Each Month in 1896.

NOTE. — Leicester Reservoir, height of rollway, 37.40 feet; Holden Reservoir, height of rollway, 30.10 feet.

Date.	Height of Water.		Date.	Height of Water.	
	Leicester.	Holden.		Leicester.	Holden.
1896.	Feet.	Feet.	1896.	Feet.	Feet.
Jan. 1,	37.65	30.60	July 1,	33.60	28.40
Feb. 1,	36.70	30.10	Aug. 1,	30.10	26.68
Mar. 1,	39.10	32.00	Sept. 1,	25.70	24.00
April 1,	37.70	30.40	Oct. 1,	23.50	23.53
May 1,	37.02	30.60	Nov. 1,	23.74	25.00
June 1,	35.06	29.70	Dec. 1,	24.10	27.56

WATER SUPPLY OF WRENTHAM.

The advice of the State Board of Health to Lincoln, Bacon & Co. with reference to the protection of the purity of Bacon's Pond in the village of Plainville in that town, from which water is drawn for the supply of several families in the village, may be found on page 77 of this volume. Samples of water collected from the pond and from a spring from which a portion of the water supply is taken are given in the following tables: —

Chemical Examination of Water from Spring in Wrentham.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity	Sediment.	Color.		Free.	Albuminoid		Nitrates.	Nitrites.			
	1896.												
16161	Feb. 24	None.	V. slight.	.10	2.40	.0000	.0030	.35	.0030	.0000	.13	0.5	.0020

Odor, none. —— The sample was collected from a spring from which a part of the supply for the village is drawn.

Microscopical Examination.

No organisms.

WRENTHAM.

Chemical Examination of Water from Bacon's Pond, Wrentham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
16116	Feb. 21	Distinct.	Slight.	.20	3.10	0.75	.0012	.0068	.0054	.0014	25	.0050	.0000	.13	0.5
16162	Feb. 28	Slight.	Slight.	.10	2.85	0.65	.0000	.0092	.0070	.0022	.31	.0160	.0000	.13	0.8

Odor of the first sample, faintly vegetable, becoming distinctly vegetable and mouldy on heating; of the last, distinctly vegetable and mouldy. —— The first sample was collected from a tap on the pump while pumping from the pond; the other, from the pond opposite the ice-house, near shore.

Microscopical Examination.

An insignificant number of organisms was found in these samples.

EXAMINATION OF RIVERS.

EXAMINATION OF RIVERS.

During the year 1896 regular monthly examinations were made of the waters of the Blackstone, Hoosac, Housatonic, Merrimack, Nashua, Neponset, Saugus and Ware rivers, and occasional examination of other rivers in the State. Nearly all of the results of these examinations will be found arranged alphabetically by rivers in the pages which follow, but some of them are given on preceding pages, in connection with the examinations of water supplies, under the names of the towns where the samples were collected, as follows: —

	PAGE
Merrimack at Lawrence,	190
Merrimack at Lowell,	204
Neponset at Hyde Park,	182
Saugus at Saugus,	216

BLACKSTONE RIVER.

The regular monthly examinations of the waters of the Blackstone River have been continued as in previous years, and the results are given in the tables which follow.

During the year ending Nov. 30, 1896, an average of 16,000,000 gallons per day of mingled sewage and brook water taken from the Mill Brook Channel were treated at the Worcester Precipitation Works, and about 3,500 tons of quicklime were used, making the amount of lime used per million gallons of sewage treated, 1,212 pounds. The effluent from the precipitation works and excess of flow of Mill Brook over the amount treated was discharged into the Blackstone River.

The first of the following tables is taken from the report of the superintendent of sewers of the city of Worcester for the year ending Nov. 30, 1896, and contains the monthly averages of analyses of samples of sewage and effluent collected at the Worcester Precipitation Works, and the percentage of matters removed from the sewage by treatment at these works.

BLACKSTONE RIVER.

WORCESTER SEWAGE PURIFICATION WORKS.

Abstract of Analyses of Sewage and Effluent.

[Taken from the annual report of the superintendent of sewers of the city of Worcester for the year ending Nov 30, 1896.]

[Parts per 100,000.

DATE OF COLLECTION.	Ammonia.				Oxygen Consumed.		
		Albuminoid.					
	Free.	Total.	Dissolved.	Suspended.	Unfiltered.	Filtered.	Chlorine.
Sewage, December, 1895,	.593	[redacted]	.160	.163	3.45	1.81	3.47
Effluent, December, 1895,	.545	.183	.163	.020	1.50	1.50	3.49
Parts removed,	.048	.145	—.003	.148	1.95	0.31	—0.02
Per cent. removed,	8.09	44.31	—1.88	88.10	56.52	17.13	—0.56
Sewage, January, 1896,	.756	.306	.148	.158	[redacted]	[redacted]	3.84
Effluent, January, 1896,	.706	.158	.148	.010	1.67	1.67	[redacted]
Parts removed,	.050	.148	.000	.148	1.95	0.38	—0.19
Per cent. removed,	6.62	48.37	[redacted]	93.67	58.87	18.54	—4.95
Sewage, February, 1896,	.676	.300	.146	.154	3.15	2.02	3.69
Effluent, February, 1896,	.648	.158	.143	.015	1.66	1.66	3.62
Parts removed,	.028	.142	.003	.139	1.49	0.36	0.07
Per cent. removed,	4.14	47.33	2.05	90 00	47.30	17.82	1.90
Sewage, March, 1896,	.470	.233	.113	.120	2.65	1.56	[redacted]
Effluent, March, 1896,	.434	.119	.102	.017	1.29	[redacted]	2.77
Parts removed,	.036	.114	.011	.103	1.36	0.27	0.08
Per cent. removed,	7.66	48.93	9.73	85.83	51.33	17.31	2.81
Sewage, April, 1896,	1.000	.409	.216	.193	[redacted]	2.05	4.53
Effluent, April, 1896,	.896	.195	.182	.013	1.81	1.81	4.52
Parts removed,	.104	.214	.034	.180	1.68	0.24	0.01
Per cent. removed,	10.40	52.32	15.74	93.26	48.14	11 70	0.22
Sewage, May, 1896,	1.604	.592	.293	.299	5.75	3.10	6.38
Effluent, May, 1896,	1.480	.252	.233	.019	2.82	2.82	6.39
Parts removed,	.124	.340	.060	.280	2.93	0.28	—0.01
Per cent. removed,	7.73	57.43	20.14	93.65	50.96	9.03	—0.15
Sewage, June, 1896,	1.468	.632	[redacted]	.302	5.04	3.15	6.61
Effluent, June, 1896,	1.407	.279	.251	.028	2.62	2.62	6.61
Parts removed,	.061	.353	.079	.274	2.42	0.53	0.00
Per cent. removed,	4.15	55.85	23.94	90.73	48.00	16.83	00.00
Sewage, July, 1896,	1.402	.602	.318	.284	5.77	3.05	7.11
Effluent, July, 1896,	1.273	.255	.238	.017	2.79	2.79	7.09
Parts removed,	.129	.347	.080	.267	2.98	0.26	0.02
Per cent. removed,	9.20	57.63	25.16	94.01	51.64	8.52	00.28

BLACKSTONE RIVER.

WORCESTER SEWAGE PURIFICATION WORKS — *Concluded.*

[Parts per 100,000.]

DATE OF COLLECTION.	Ammonia.				Oxygen Consumed.		
		Albuminoid.					
	Free.	Total.	Dissolved.	Suspended.	Unfiltered.	Filtered.	Chlorine.
Sewage, August, 1896,	1.603	.743	.345	.398	6.30	3.08	8.01
Effluent, August, 1896,	1.466	.308	.282	.026	3.01	3.01	8.04
Parts removed,	.137	.435	.063	.372	3.29	0.07	—0.03
Per cent. removed,	8.55	58.55	18.26	93.46	52.23	2.27	—0.37
Sewage, September, 1896,	1.331	.677	.320	.357	5.64	2.65	6.83
Effluent, September, 1896,	1.119	.297	.267	.030	2.64	2.64	6.86
Parts removed,	.212	.380	.053	.327	3.00	0.01	—0.03
Per cent. removed,	15.93	56.13	16.56	91.60	53.37	00.37	—0.44
Sewage, October, 1896,	1.238	.565	.272	.293	5.84	2.63	6.65
Effluent, October, 1896,	1.037	.271	.249	.022	2.75	2.75	6.71
Parts removed,	.201	.294	.023	.271	3.09	—0.12	—0.06
Per cent. removed,	16.23	52.04	8.46	92.49	52.91	—2.91	—0.90
Sewage, November, 1896,	1.257	.613	.295	.318	4.94	2.49	6.18
Effluent, November, 1896,	1.106	.271	.255	.016	2.14	2.14	6.17
Parts removed,	.151	.342	.040	.302	2.80	0.35	0.01
Per cent. removed,	12.01	55.78	13.56	94.97	56.69	14.06	00.16
Sewage for year ending Dec. 1, 1896,	1.118	.497	.246	.251	4.63	2.47	5.50
Effluent for year ending Dec. 1, 1896,	1.012	.229	.209	.020	2.23	2.23	5.53
Parts removed,	.106	.268	.037	.231	2.40	0.24	—0.03
Per cent. removed,	9.48	53.92	15.04	92.02	51.62	9.72	—0.54

NOTE. — Monthly averages are made from daily analyses of sewage and effluent. The daily sewage samples consist of forty-eight portions taken half hourly. Sewage samples are taken as nearly as possible in proportion to the amount of sewage being received at the time of sampling. Effluent samples consist of twenty-four portions taken hourly.

BLACKSTONE RIVER.

AVERAGES OF CHEMICAL ANALYSES OF WATER FROM THE BLACKSTONE RIVER FOR THE YEARS 1888 TO 1896, INCLUSIVE.

Blackstone River between Mill Brook Channel and the Sewage Precipitation Works.

[Parts per 100,000.]

YEAR.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.	
1888,	0.64	–	–	.2112	.1040	–	–	1.21	.0370	.0029	–
1889,	0.76	–	–	.2841	.1198	.0629	.0569	1.06	.0235	.0024	–
1890,	0.82	–	–	.1800	.1024	.0549	.0475	1.03	.0367	.0014	–
1891,	0.80	13.54	4.00	.3340	.1563	.0840	.0723	1.73	.0343	.0032	4.6
1892,	0.71	16.28	4.86	.2530	.1262	.0627	.0635	1.84	.0312	.0061	4.9
1893,	0.68	17.95	4.85	.1429	.0603	.0326	.0277	1.04	.0180	.0012	4.5
1894,	0.86	17.17	5.58	.0739	.0570	.0304	.0260	0.88	.0195	.0006	3.7
1895,	0.84	13.40	4.02	.0507	.0374	.0229	.0145	0.86	.0173	.0007	2.9
1896,	0.75	12.69	3.37	.0759	.0486	.0309	.0177	1.01	.0187	.0010	2.9

Blackstone River below Sewage Precipitation Works.

1888,	0.64	–	–	.2112	.1040	–	–	1.21	.0370	.0029	–
1889,	0.76	–	–	.2841	.1198	.0629	.0569	1.06	.0236	.0024	–
1890,	0.74	–	–	.2253	.1177	.0581	.0596	1.26	.0381	.0016	–
1891,	0.80	18.62	4.52	.4080	.1303	.0695	.0606	1.91	.0388	.0031	4.6
1892,	0.63	19.35	5.29	.3633	.1442	.0737	.0705	2.21	.0278	.0033	7.2
1893,	0.74	25.63	6.64	.3757	.1447	.0864	.0583	1.98	.0369	.0070	7.4
1894,	0.60	25.76	6.61	.4228	.1309	.0946	.0363	2.13	.0316	.0047	7.9
1895,	0.79	19.14	4.78	.2298	.0840	.0573	.0267	1.52	.0347	.0040	5.9
1896,	0.40	24.28	6.36	.2645	.0930	.0615	.0315	1.91	.0356	.0071	8.3

Blackstone River at Uxbridge.

1888,	0.45	–	–	.0979	.0284	–	–	0.61	.0322	.0008	–
1889,	0.28	–	–	.0992	.0300	.0191	.0109	0.60	.0253	.0009	–
1890,	0.25	–	–	.1168	.0214	.0152	.0062	0.66	.0272	.0008	–
1891,	0.27	6.32	1.94	.1647	.0273	.0197	.0075	0.77	.0396	.0008	2.8
1892,	0.21	8.50	1.90	.2113	.0222	.0153	.0069	0.82	.0326	.0007	2.6
1893,	0.40	9.45	1.91	.1603	.0256	.0167	.0089	1.00	.0424	.0029	3.2
1894,	0.51	10.80	1.97	.1372	.0242	.0187	.0055	1.22	.0460	.0032	4.0
1895,	0.64	10.56	2.44	.1061	.0315	.0243	.0072	1.05	.0439	.0037	3.9
1896,	0.42	10.77	2.50	.1209	.0308	.0249	.0059	1.09	.0405	.0054	4.2

Blackstone River at Millville.

1888,	0.47	–	–	.0444	.0253	–	–	0.44	.0242	.0005	–
1889,	0.38	–	–	.0450	.0277	.0206	.0071	0.43	.0160	.0004	–
1890,	0.34	–	–	.0587	.0211	.0162	.0049	0.46	.0240	.0004	–
1891,	0.32	6.05	1.83	.0807	.0293	.0194	.0099	0.55	.0276	.0005	1.9
1892,	0.35	6.03	1.62	.0898	.0249	.0180	.0069	0.64	.0218	.0004	1.8
1893,	0.40	6.23	1.53	.0899	.0288	.0225	.0063	0.66	.0289	.0008	2.0
1894,	0.49	6.37	1.90	.0628	.0219	.0173	.0046	0.73	.0282	.0008	2.5
1895,	0.58	7.47	2.27	.0501	.0253	.0189	.0064	0.74	.0278	.0016	2.7
1896,	0.40	7.34	1.64	.0549	.0246	.0185	.0063	0.76	.0347	.0018	2.8

BLACKSTONE RIVER.

AVERAGES OF CHEMICAL ANALYSES OF WATER FROM THE BLACKSTONE RIVER FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE, OF EACH YEAR FROM 1887 TO 1896, INCLUSIVE.

Blackstone River between Mill Brook Channel and the Sewage Precipitation Works.

[Parts per 100,000.]

MONTHS.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
June-Nov., 1887,	0.91	–	–	.2686	.1741	–	–	1.35	.0160	–	–
" " 1888,	0.76	–	–	.2658	.1112	.0557	.0555	1.50	.0382	.0041	–
" " 1889,	0.86	–	–	.3080	.1430	.0772	.0658	1.32	.0177	.0026	–
" " 1890,	1.14	9.92	3.03	.2107	.1246	.0673	.0573	1.07	.0250	.0015	2.9
" " 1891,	1.10	17.42	5.59	.4913	.1950	.1127	.0823	2.29	.0192	.0057	5.0
" " 1892,	0.52	20.75	6.30	.3547	.1433	.0708	.0725	2.43	.0227	.0108	6.1
" " 1893,	0.40	16.98	4.55	.1480	.0588	.0240	.0348	1.01	.0115	.0015	6.3
" " 1894,	0.66	16.93	4.76	.0548	.0380	.0236	.0144	0.74	.0115	.0006	4.4
" " 1895,	0.49	14.17	4.50	.0613	.0414	.0243	.0171	0.94	.0163	.0006	3.4
" " 1896,	0.51	12.90	2.93	.0760	.0415	.0282	.0133	0.97	.0147	.0015	3.4

Blackstone River below Sewage Precipitation Works.

MONTHS.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
June-Nov., 1887,	0.91	–	–	.2686	.1741	–	–	1.35	.0160	–	–
" " 1888,	0.76	–	–	.2658	.1112	.0557	.0556	1.50	.0382	.0041	–
" " 1889,	0.86	–	–	.3080	.1430	.0772	.0658	1.32	.0177	.0026	–
" " 1890,	0.97	11.36	3.10	.2907	.1492	.0722	.0770	1.46	.0276	.0018	3.9
" " 1891,	1.05	22.25	6.60	.6367	.1508	.0853	.0625	2.61	.0233	.0040	6.2
" " 1892,	0.63	26.80	7.75	.5240	.1810	.0958	.0852	3.13	.0137	.0050	10.3
" " 1893,	0.51	30.00	7.13	.5680	.1453	.0900	.0553	2.76	.0285	.0126	10.9
" " 1894,	0.40	29.30	5.86	.6149	.1390	.1113	.0277	2.63	.0212	.0071	10.6
" " 1895,	0.71	22.15	5.18	.3246	.0898	.0597	.0301	1.86	.0267	.0063	7.8
" " 1896,	0.30	26.03	6.55	.2831	.0898	.0600	.0298	2.10	.0217	.0116	9.7

Blackstone River at Uxbridge.

MONTHS.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
June-Nov., 1887,	0.39	–	–	.1129	.0271	–	–	0.79	.0360	–	–
" " 1888,	0.35	6.42	1.52	.1165	.0258	.0222	.0066	0.68	.0319	.0007	–
" " 1889,	0.32	–	–	.1133	.0296	.0192	.0104	0.66	.0353	.0009	–
" " 1890,	0.26	8.86	2.12	.1629	.0231	.0174	.0057	0.79	.0259	.0003	2.9
" " 1891,	0.20	10.16	2.61	.2280	.0175	.0117	.0058	1.04	.0425	.0007	3.6
" " 1892,	0.13	9.36	1.88	.2840	.0227	.0162	.0065	0.99	.0313	.0007	3.1
" " 1893,	0.24	11.74	2.37	.1965	.0207	.0140	.0067	1.20	.0623	.0050	4.2
" " 1894,	0.35	13.07	2.03	.1456	.0243	.0183	.0060	1.57	.0673	.0050	4.9
" " 1895,*	0.56	12.95	2.60	.0906	.0258	.0182	.0076	1.34	.0631	.0065	4.7
" " 1896,	0.33	12.08	2.67	.1129	.0257	.0221	.0036	1.38	.0477	.0091	5.0

Blackstone River at Millville.

MONTHS.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
June-Nov., 1887,	0.31	–	–	.0458	.0220	–	–	0.51	.0210	–	–
" " 1888,	0.41	5.22	1.40	.0467	.0296	.0233	.0063	0.60	.0278	.0004	–
" " 1889,	0.38	–	–	.0490	.0273	.0213	.0060	0.45	.0167	.0003	–
" " 1890,	0.26	6.71	2.24	.0736	.0196	.0152	.0044	0.53	.0229	.0005	2.3
" " 1891,	0.24	7.48	2.35	.1105	.0384	.0234	.0150	0.72	.0308	.0006	2.2
" " 1892,	0.37	6.70	1.62	.1143	.0294	.0210	.0084	0.63	.0217	.0002	2.0
" " 1893,	0.23	7.43	1.73	.0677	.0119	.0087	.0031	0.77	.0385	.0011	2.6
" " 1894,	0.47	8.42	2.16	.0510	.0172	.0139	.0033	0.69	.0273	.0012	2.6
" " 1895,	0.61	8.67	2.55	.0356	.0233	.0180	.0053	0.90	.0383	.0024	3.2
" " 1896,	0.45	8.63	1.69	.0484	.0237	.0180	.0057	0.97	.0413	.0027	3.3

* Average of five months. No sample was obtained in June.

BLACKSTONE RIVER.

Chemical Examination of Water from Blackstone River between

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total Residue. Total.	Total Residue. Dis-solved.	Total Residue. Sus-pended.	Loss on Ignition. Total.	Loss on Ignition. Dis-solved.	Loss on Ignition. Sus-pended.
		1896.									
1	16936	Jan. 22	Decided.	Cons.	1.30	10.60	8.80	1.80	3.80	2.60	1.20
2	16107	Feb. 19	Decided.	Cons.	1.05	10.50	8.60	1.90	3.60	2.70	0.90
3	16287	Mar. 18	Decided.	Cons.	1.10	13.20	10.20	3.00	4.80	2.80	2.00
4	16467	Apr. 22	Distinct.	Cons.	0.76	8.00	4.80	3.20	2.00	1.60	[illegible]
5	16639	May 20	Thick, rusty.	Heavy, brown.	0.83	21.20	12.60	8.60	5.80	3.00	[illegible]
6	16813	June 17	Decided, rusty.	Cons., rusty.	0.02	22.00	20.40	1.60	3.40	3.40	0.00
7	17039	July 22	Decided, rusty.	Cons., rusty.	0.10	10.20	4.60	5.60	2.60	1.40	1.20
8	17254	Aug. 19	Decided, milky.	Cons., brown.	0.38	15 20	10.00	5.20	3.80	2.40	1.40
9	17469	Sept. 16	Decided, milky.	Cons., brown.	0.97	9.80	6.80	3.00	2.00	1.40	0.60
10	17691	Oct. 21	Decided, milky.	Cons.	1.25	11 00	9.00	2.00	3.20	2.00	1.20
11	17916	Nov. 18	Decided.	Cons.	0.35	9.20	7.60	1.60	2.60	1.20	1.40
12	18151	Dec. 17	Decided, milky.	Cons., dark.	0.95	11.40	8.80	2.60	2.80	2.60	0.20
13	Av.	....	....	....	0.75	12.69	9.35	3.34	3.37	2.26	1.11

Odor, disagreeable. —— The samples were collected from the river, about 200 feet below the iron Wednesday. The samples were collected at various hours between 8.15 A.M. and 1.30 P.M.

Chemical Examination of Water from Blackstone

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total Residue. Total.	Total Residue. Dis-solved.	Total Residue. Sus-pended.	Loss on Ignition. Total.	Loss on Ignition. Dis-solved.	Loss on Ignition. Sus-pended.
		1896.									
1	15937	Jan. 22	Decided.	Heavy.	.18	28.20	23.20	5.00	9.00	6.60	2.40
2	16108	Feb. 19	Decided.	Cons.	.73	17.00	14.20	2.80	5.60	4.80	0.80
3	16288	Mar. 18	Decided.	Cons.	.30	15.60	12.20	3.40	4.00	2.20	1.80
4	16468	Apr. 22	Decided.	Cons	.70	13.80	11 40	2.40	3.40	2.80	0.60
5	16640	May 20	Decided, rusty.	Heavy, rusty.	.80	33 60	23.60	10.00	9.00	4.80	4.20
6	16814	June 17	Distinct, brown.	Heavy, brown.	.02	28.40	24.40	4.00	10.40	8.60	1.80
7	17040	July 22	Distinct, yellow.	Cons., brown.	.30	22.40	19.80	2 60	4 80	3.80	1.00
8	17255	Aug. 19	Decided, milky.	Cons., rusty.	.35	25.60	22.80	2.80	5.40	2.60	2.80
9	17470	Sept. 15	Decided, milky.	Cons., rusty.	.30	27.20	24.40	2.80	6 80	5.00	1.80
10	17692	Oct. 21	Decided, rusty.	Cons., rusty.	.30	30.40	27 40	3.00	6.20	5.60	0.60
11	17917	Nov. 18	Decided.	Heavy.	.65	22.20	18.20	4.00	5.60	[illegible]	1.60
12	18152	Dec. 17	Decided, milky.	Cons., rusty.	.28	27.00	22.00	5.00	6.20	6.00	0.20
13	Av.	....	....	....	.40	24.28	20.30	[illegible]	6.36	4.73	1.63

Odor, disagreeable, frequently offensive. —— The samples were collected from the river above Mill- the river. No. 17470 was collected on Tuesday, No. 18152 on Thursday, and the other samples on

BLACKSTONE RIVER.

Mill Brook Channel and the Worcester Sewage Precipitation Works.

[Parts per 100,000.]

Ammonia.					Nitrogen as		Iron.			
	Albuminoid.									
Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Unfiltered.	Filtered.	Hardness.	
.0620	.0510	.0350	.0160	0.92	.0270	.0007	.4900	.3800	1.8	1
.0472	.0234	.0144	.0090	1.50	.0470	.0012	.5300	.3200	3.2	2
.1960	.0950	.0760	.0190	1.05	.0250	.0010	.9200	.4400	2.2	3
.0144	.0278	.0192	.0086	0.41	.0150	.0003	.5900	.1300	1.5	4
.1160	.1030	.0340	.0690	1.73	.0030	.0000	.9800	.1700	3.4	5
.2880	.0620	.0490	.0130	1.98	.0350	.0055	.4200	.0040	8.4	6
.0272	.0316	.0146	.0170	0.58	.0050	.0004	.8700	.0060	2.1	7
.0760	.0470	.0216	.0254	0.66	.0050	.0005	.4500	.0480	2.5	8
.0336	.0366	.0268	.0098	0.72	.0060	.0005	.6600	.2160	1.8	9
.0278	.0396	.0360	.0036	1.10	.0150	.0015	.4400	.4200	2.5	10
.0156	.0322	.0214	.0108	0.80	.0220	.0005	.7200	.2800	2.9	11
.0168	.0342	.0234	.0108	0.73	.0200	.0004	.2700	.1440	2.3	12
.0759	.0486	.0309	.0177	1.01	.0187	.0010	.6117	.2132	2.9	13

bridge. No. 17469 was collected on Tuesday, No. 18151 on Thursday, and the other samples on

River below the Worcester Sewage Precipitation Works.

[Parts per 100,000.]

Ammonia.					Nitrogen as		Iron.			
	Albuminoid.									
Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Unfiltered.	Filtered.	Hardness.	
.3680	.1020	.0770	.0250	2.05	.0800	.0040	0.7300	0.0280	9.5	1
.1800	.0880	.0610	.0270	1.62	.0650	.0025	0.3500	0.1950	5.1	2
.1560	.0880	.0360	.0520	1.27	.0370	.0016	1.4000	0.0700	4.2	3
.1400	.0630	.0470	.0160	1.08	.0350	.0018	0.3100	0.1480	4.4	4
.4240	.1700	.1090	.0610	2.48	.0050	.0001	0.8200	0.1120	9.4	5
.0600	.0430	.0270	.0160	0.82	.0100	.0007	7.4000	6.1200	-	6
.3600	.0980	.0670	.0310	2.22	.0030	.0000	0.3900	0.0160	8.9	7
.3520	.1070	.0800	.0270	2.41	.0030	.0300	0.3500	0.0160	9.8	8
.4800	.1260	.0840	.0420	2.90	.0040	.0160	0.3100	0.0160	9.7	9
.4080	.1450	.0940	.0510	2.60	.0650	.0160	0.4600	0.0300	12.6	10
.0384	.0200	.0078	.0122	1.63	.0450	.0080	0.9400	0.1360	7.6	11
.2080	.0656	.0480	.0176	1.86	.0750	.0040	0.2900	0.0100	10.4	12
.2645	.0930	.0615	.0315	1.91	.0356	.0071	1.1458	0.5747	8.3	13

bury and below the point where the effluent from the Worcester Sewage Precipitation Works enters
Wednesday. The samples were collected at various hours between 8.30 A.M. and 1.40 P.M.

BLACKSTONE RIVER.

Chemical Examination of Water from Blackstone River at Uxbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
15943	Jan. 23	Distinct.	Slight.	.60	9.90	2.90	.1600	.0330	.0240	.0090	0.97	.0330	.0013	.47	3.6
16112	Feb. 20	Distinct.	Slight.	.58	7.30	2.10	.0960	.0390	.0340	.0050	0.63	.0400	.0011	.40	2.7
16293	Mar. 19	Distinct.	Cons.	.35	7.70	2.60	.0840	.0270	.0200	.0070	0.60	.0360	.0011	.32	1.8
16472	Apr. 23	Distinct.	Slight, rusty.	.60	8.20	2.20	.1520	.0430	.0370	.0060	0.70	.0300	.0020	.34	3.3
16651	May 21	Distinct.	Cons., rusty.	.25	9.30	1.80	.1680	.0400	.0250	.0150	1.00	.0300	.0040	.35	4.1
16825	June 18	Decided.	Slight.	.30	9.90	1.00	.2100	.0230	.0200	.0030	1.14	.0350	.0095	.37	4.5
17069	July 27	Distinct.	Cons., rusty.	.26	14.00	3.10	.0128	.0270	.0236	.0034	1.58	.0950	.0180	.34	4.6
17258	Aug. 20	Slight, milky.	Slight.	.23	14.00	3.10	.0068	.0234	.0190	.0044	1.54	.0500	.0020	.37	5.4
17490	Sept. 17	Distinct.	Cons., brown.	.25	13.70	3.50	.1040	.0224	.0164	.0060	1.46	.0310	.0180	.35	5.6
17698	Oct. 22	Distinct, milky	Slight.	.40	13.70	2.00	.1680	.0310	.0270	.0040	1.43	.0650	.0050	.45	5.4
17919	Nov. 19	Distinct.	Slight.	.55	10.80	2.70	.1500	.0266	.0246	.0020	1.14	.0100	.0020	.43	4.2
18149	Dec. 17	Distinct, milky	Slight.	.63	9.70	2.40	.1136	.0336	.0268	.0068	0.97	.0320	.0012	.49	4.0
Av.	....	....	....	.42	10.77	2.50	.1209	.0308	.0249	.0059	1.09	.0405	.0054	.39	4.2

Odor, generally musty, frequently disagreeable. —— The samples were collected from the canal leading from the upper dam of the Calumet Woolen Company to the mill, just before the water passed the screens.

Chemical Examination of Water from Blackstone River at Millville, Blackstone.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
15942	Jan. 23	Distinct.	Slight.	.60	6.50	1.60	.0672	.0204	.0152	.0052	0.54	.0250	.0004	.44	2.6
16115	Feb. 20	Distinct, milky	Slight.	.50	6.00	1.80	.0640	.0250	.0180	.0070	0.46	.0380	.0008	.40	1.9
16292	Mar. 19	Distinct.	Slight.	.37	5.10	0.90	.0440	.0320	.0170	.0150	0.41	.0250	.0006	.34	1.6
16461	Apr. 22	Distinct.	Slight.	.50	6.00	1.80	.0752	.0174	.0144	.0030	0.52	.0200	.0014	.45	2.3
16652	May 21	Distinct.	Slight, rusty.	.30	6.10	1.50	.0000	.0300	.0220	.0080	0.59	.0350	.0020	.32	2.4
16824	June 18	Decided.	Slight.	.30	5.10	0.60	.0664	.0296	.0148	.0148	0.64	.0350	.0038	.49	2.6
17047	July 23	Distinct.	Slight.	.28	9.65	2.05	.0064	.0248	.0192	.0056	1.19	.0680	.0045	.29	3.6
17259	Aug. 20	Slight.	Slight.	.23	10.05	1.65	.0024	.0202	.0176	.0026	1.20	.0400	.0005	.33	3.9
17492	Sept. 17	Distinct.	Slight.	.25	10.00	2.40	.0400	.0210	.0162	.0048	1.10	.0200	.0045	.37	3.6
17711	Oct. 22	Distinct, milky.	Slight.	.40	8.90	2.20	.0950	.0240	.0220	.0020	0.99	.0400	.0020	.43	3.4
17918	Nov. 18	Distinct.	Slight.	.42	7.50	1.25	.0704	.0228	.0184	.0044	0.74	.0450	.0008	.39	2.7
18150	Dec. 17	Distinct, clayey.	Slight.	.45	7.20	1.90	.0376	.0300	.0266	.0034	0.74	.0250	.0005	.50	2.4
Av.	....	....	....	.40	7.34	1.64	.0540	.0249	.0185	.0063	0.76	.0347	.0018	.40	2.8

Odor, musty, frequently becoming disagreeable on heating. —— The samples were collected from the river, just above the dam in the village of Millville.

Charles River.

Chemical Examination of Water from the Charles River at Medway.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
16715	June 2	Distinct.	Slight.	1.30	4.65	2.45	.0060	.0286	.0256	.0030	.29	.0050	.0000	1.04	0.8

Odor, distinctly vegetable. —— The sample was collected from Charles River just below the dam at Ray and Wilson's mill in the easterly part of the town of Medway.

Hoosac River.

Chemical Examination of Water from the Hoosac River at Williamstown.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
15968	Jan. 27	Decided, clayey	Slight, earthy.	.12	10.90	2.90	.0028	.0192	.0138	.0054	0.25	.0380	.0008	.37	6.5
16086	Feb. 18	Decided, milky	Cons., white.	.20	17.70	5.70	.0844	.0704	.0556	.0148	1.12	.1600	.0042	.56	10.0
16270	Mar. 18	Decided, milky	Slight, earthy.	.20	14.20	4.85	.0452	.0760	.0454	.0306	0.55	.0550	.0009	.95	7.3
16462	Apr. 21	Distinct, milky.	Cons., dark.	.23	7.00	1.80	.0004	.0168	.0124	.0044	0.17	.0180	.0004	.36	4.4
16619	May 19	Decided, milky.	Cons., earthy.	.30	11.90	2.40	.0004	.0280	.0180	.0100	0.44	.0170	.0010	.48	8.9
16816	June 16	Distinct, floc.	Cons., floc.	.15	10.80	2.10	.0060	.0272	.0150	.0122	0.42	.0120	.0010	.26	8.2
17031	July 21	Distinct, milky.	Cons.	.30	14.00	2.80	.0488	.0318	.0246	.0072	0.49	.0100	.0020	.35	10.4
17231	Aug. 18	Distinct.	Cons.	.20	11.05	2.55	.0560	.0256	.0194	.0062	0.36	.0100	.0040	.35	8.5
17465	Sept. 15	Distinct, milky.	Cons., brown.	.25	12.60	2.60	.0456	.0238	.0148	.0090	0.39	.0080	.0020	.33	9.6
17674	Oct. 20	Decided, milky	Cons.	.20	10.90	2.00	.0184	.0204	.0144	.0060	0.30	.0180	.0010	.30	8.1
17880	Nov. 17	Decided, milky.	Cons.	.18	10.00	2.60	.0020	.0312	.0150	.0162	0.38	.0220	.0010	.37	7.1
18144	Dec. 15	Distinct, milky.	Slight.	.15	10.00	2.90	.0002	.0206	.0120	.0086	0.37	.0200	.0005	.39	7.7

Averages by Years.

-	1887*	-	-	.21	11.50	1.23	.0057	.0178	-	-	0.22	.0239	-	-	-
-	1888	-	-	.10	10.21	1.65	.0040	.0187	.0143	.0044	0.24	.0308	.0010	-	-
-	1889†	-	-	.08	8.74	1.18	.0071	.0162	.0104	.0058	0.18	.0254	.0006	-	-
-	1894	-	-	.23	10.77	2.13	.0111	.0265	.0109	.0046	0.35	.0157	.0009	.34	7.8
-	1895	-	-	.28	12.41	2.95	.0146	.0334	.0207	.0127	0.39	.0162	.0013	.40	8.1
-	1896	-	-	.21	11.53	2.91	.0261	.0326	.0217	.0109	0.44	.0323	.0015	.44	8.1

* June to December. † January to May.

Note to analyses of 1896. Odor, generally musty, frequently also tarry or disagreeable. —— The samples were collected from the river at the bridge, near the Williamstown station on the Fitchburg Railroad.

Housatonic River.

Chemical Examination of Water from the Housatonic River at New Lenox.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15906	Jan. 20	Slight, milky.	Slight.	.20	12.30	2.30	.0314	.0206	.0170	.0036	.29	.0330	.0020	.35	9.6
16114	Feb. 20	Decided, clayey	Slight, earthy.	.27	10.90	2.40	.0076	.0196	.0140	.0050	26	.0280	.0004	.46	8.3
16265	Mar. 17	Distinct, clayey	Slight, earthy.	.25	8.80	1.00	.0070	0196	.0128	.0068	.17	.0280	.0008	.31	[illegible]
16438	Apr 20	Decided, milky.	Cons.	.36	6.75	1.55	.0040	.0214	.0138	.0076	.11	.0150	.0002	.38	4.6
16654	May 21	Distinct.	Cons., brown.	.22	11.30	2.30	.0104	.0224	0186	.0038	.21	.0200	.0010	.29	8.6
16787	June 15	Distinct.	Cons., brown	.30	11.60	2.90	.0472	.0186	.0144	.0042	.26	.0080	.0016	.31	9.7
17021	July 21	Slight.	Slight.	.18	13.00	0.70	.0122	.0170	.0136	.0034	.29	.0160	.0135	.27	10.1
17218	Aug 17	Slight.	Slight.	.20	12.35	2.20	.0120	[illegible]	.0172	.0030	.22	.0170	.0175	.36	10.0
17455	Sept 14	Slight.	Cons., brown.	.30	13.00	2.40	.0229	.0174	.0144	0030	.21	0200	.0050	.41	9.7
17671	Oct. 20	Distinct.	Slight.	.31	11.00	3.40	.0092	.0218	.0194	.0024	.20	.0180	0008	.46	8.1
17871	Nov. 16	Distinct, floc	Cons., brown.	.33	12.40	2.50	.0812	.0154	.0134	.0020	.23	.0250	.0010	.32	10.4
18123	Dec. 15	Distinct.	Cons.	.25	10.60	1.70	.0078	.0168	.0138	.0030	.22	.0250	.0005	.34	9.1

Averages by Years.

-	1893*	-	-	.30	9.73	2.21	.0058	.0174	.0134	.0040	.16	.0175	.0014	.42	7.0
-	1894	-	-	.27	11.37	2.19	.0131	.0183	.0144	.0039	25	.0204	.0024	.35	8.5
-	1895	-	-	.26	11.73	2.50	.0182	.0238	.0183	.0055	.25	.0173	.0036	.43	8.4
-	1896	-	-	[illegible]	11.18	1.97	.0169	.0192	.0152	.0040	.22	.0205	.0036	.36	8.6

* March to December.

NOTE to analyses of 1896: Odor, musty. —— The samples were collected from the river.

Merrimack River.

The usual monthly examinations of the water of this river opposite the intakes of the Lowell and the Lawrence Water Works have been continued during 1896, the detailed results of which may be found on pages 204 and 190 of this volume. A comparison of the analyses made at these two places during the year is given in the following table: —

Table comparing the Analyses above Lowell with those above Lawrence, 1896.

[Parts per 100,000.]

		Residue on Evaporation.		Ammonia.					Nitrogen as		
					Albuminoid.						
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Hardness.
Number of determinations compared,	12	12	12	12	12	12	12	12	[illegible]	12	[illegible]
Mean of analyses above Lowell,	.40	3.47	1.28	.0034	.0167	.0136	.0031	.167	.0070	.0001	1.0
Mean of analyses above Lawrence,	.42	3.98	1.52	.0068	.0220	.0183	.0037	.237	.0087	.0003	1.2
Increase,	.02	0.51	0.24	.0034	.0053	.0047	.0006	.070	.0017	.0002	0.2

In order to compare these results with similar ones obtained in previous years, another table is presented, which shows the increase in impurities as the water passes from a point above Lowell to Lawrence, as given in the last line of the above table, and the corresponding increase in previous years: —

Increase in the Amount of Impurities in the Merrimack River Water, from a Point above Lowell to Lawrence, as determined by the Regular Monthly Examinations of Different Years.

[Parts per 100,000.]

Date.		Residue on Evaporation.		Ammonia.					Nitrogen as		
					Albuminoid.						
	Color.	Total.	Loss on Ignition.	[illegible]	Total.	Dissolved.	Suspended	Chlorine.	Nitrates.	Nitrites.	Hardness.
Increase, 1887-1889,	0.01	0.23	0.09	.0007	.0027	.0017	.0010	.026	.0003*	.0000	–
Increase, 1890,	0.05	0.62	0.22*	.0016	.0023	.0017	.0006	.028	[illegible]	.0000	0.2
Increase, 1891,	0.02*	0.29	0.07	.0021	.0023	.0021	.0002	.035	.0030*	.0000	0.1
Increase, 1892,	0.06	[illegible]	0.12	.0019	.0037	.0037	.0000	.039	.0013*	.0000	0.0
Increase, 1893,	0.09	0.47	0.30	.0031	[illegible]	.0021	.0011	.035	.0002*	.0001	0.0
Increase, 1894,	0.02	0.16	0.04	.0028	.0032	[illegible]	.0000	.049	.0000	.0000	0.1
Increase, 1895,	0.11	0.62	0.33	.0022	.0063	.0046	.0017	.063	.0005	.0001	0.1
Increase, 1896,	0.02	0.51	0.24	.0034	.0053	.0047	.0006	.070	.0017	.0002	0.2

* Decrease.

The average flow of the river at Lawrence, for twenty-four hours, during the days on which samples were collected, was for the above periods, respectively, at the rate of 9,145, 9,948, 7,931, 6,434, 8,126, 5,459, 11,694 and 5,686 cubic feet per second.

NASHUA RIVER.

Chemical Examination of Water from the North Branch of the Nashua River, below Fitchburg.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16025	Jan. 21	Decided	Cons.	.37	6.25	2.10	.0468	.0384	.0290	.0094	0.44	.0150	.0003	.70	1.6
16109	Feb 19	Distinct.	Decided.	.33	11.25	2.30	.0252	.0326	.0246	.0080	0.50	.0270	.0003	.70	1.6
16263	Mar 17	Decided, milky	Cons., earthy.	.38	6.40	2.85	.0742	.0632	.0440	.0192	0.50	.0250	.0002	.70	1.4
16451	Apr. 21	Distinct, milky.	Cons., floc.	.40	4.70	1.70	.0212	.0314	.0264	.0050	0.39	.0080	.0004	.58	1.6
16636	May 19	Decided, milky	Cons.	.33	6.70	2.00	.0600	.0720	.0300	.0420	0.78	.0070	.0010	.52	0.9
16915	June 16	Decided, milky.	Cons., brown.	.50	7.70	2.10	.0760	.0470	.0310	.0160	[illegible]	.0100	.0014	.50	1.9
17045	July 22	Distinct.	Cons.	.70	10.10	2.60	.1360	.0550	.0380	.0170	1.10	.0070	.0020	.60	2.7
17318	Aug 27	Distinct.	Cons.	.70	11.60	3.10	.0960	.0610	.0430	.0180	1.20	.0070	.0045	.55	2.7
17468	Sept. 15	Decided, milky.	Cons., brown.	.40	9.55	2.85	.1040	.0380	.0330	.0050	1.07	.0150	.0080	.47	2.4
17675	Oct. 20	Decided.	Cons.	.67	6.25	2.40	.0560	.0560	.0480	.0080	[illegible]	.0150	.0010	.39	2.7
17881	Nov. 17	Decided, milky.	Cons.	.48	8.45	2.80	.0708	.0654	.0376	.0278	0.64	.0220	.0012	.78	2.1
18127	Dec. 15	Decided, milky.	Cons.	.50	6.80	2.20	.0464	.0392	.0270	.0122	0.63	.0200	.0007	.78	2.0

Averages by Years.

-	1893	-	-	.67	7.46	2.16	.0461	.0360	.0257	.0103	0.69	.0118	.0018	.69	2.0
-	1894	-	-	.56	7.39	2.00	.0634	.0346	.0251	.0095	0.75	.0152	.0020	.58	1.9
-	1895	-	-	.59	8.10	2.58	.0832	.0423	.0319	.0104	0.75	.0134	.0010	.74	2.2
-	1896	-	-	.48	8.15	2.40	.0677	.0499	.0343	.0156	0.74	.0151	.0017	.60	2.0

NOTE to analyses of 1896: Odor, generally musty and disagreeable. —— The samples were collected from the river, about half a mile below the point where water from the tail-race of the Falulah Paper Company enters the stream.

NASHUA RIVER.

Chemical Examination of Water from the North Branch of the Nashua River, just above its Confluence with the South Branch at Lancaster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1896.														
15941	Jan. 28	Distinct.	Cons.	.35	6.50	1.75	.0240	.0284	.0172	.0112	.45	.0200	.0002	.48	1.6
16098	Feb. 19	Decided, milky.	Slight, floc	.33	5.90	1.95	.0212	.0290	.0194	.0096	.41	[illegible]	.0005	.62	1.7
16282	Mar. 18	Decided, clayey.	Cons., floc.	.30	5.20	1.80	.0050	.0238	.0174	.0064	.40	.0060	.0003	.49	1.5
16466	Apr. 22	Distinct.	Slight.	.42	3.70	1.50	.0050	.0238	.0194	[illegible]	.24	.0120	.0002	.50	1.2
16649	May 20	Distinct.	Cons.	.43	5.80	1.90	.0060	–	–	–	.58	.0060	.0012	.39	1.7
16834	June 18	Distinct, milky.	Cons., brown.	.50	6.40	2.05	.0470	.0828	.0896	.0032	.56	.0200	.0025	.56	1.8
17044	July 22	Distinct.	Slight, earthy	28	5.75	1.65	.0032	.0202	.0138	.0064	.54	.0120	.0003	.34	1.7
17253	Aug. 19	Decided, green.	Cons., brown	.80	8.25	2.65	.0132	.0520	.0324	.0196	.80	.0100	.0065	.70	2.3
17428	Sept. 16	Slight.	Cons.	.70	7.65	2.20	.0248	.0258	.0242	.0016	.76	.0200	.0086	.61	2.2
17693	Oct. 21	Distinct.	Slight.	.53	7.40	2.65	.0276	.0280	.0236	.0044	.70	.0180	.0020	.73	2.1
17896	Nov. 18	Distinct, milky.	Cons.	.60	6.40	1.90	.0360	.0342	.0282	.0060	.60	.0200	.0005	.65	1.9
18153	Dec. 17	Distinct, clayey.	Slight.	.38	5.95	1.65	.0394	.0246	.0218	.0028	.58	.0150	.0003	.58	2.2

Averages by Years.

–	1888*	–	–	.56	7.47	1.82	.0118	.0287	.0261	.0026	0.72	.0257	[illegible]	–	–
–	1890†	–	–	.38	6.77	2.12	.0117	.0326	.0274	.0052	0.82	.0214	.0014	–	2.6
–	1891‡	–	–	.46	10.20	2.26	[illegible]	.0266	.0235	.0031	1.18	.0331	.0012	–	2.8
–	1892§	–	–	.49	9.75	2.10	.0422	.0274	.0237	.0037	1.11	.0450	.0010	–	3.0
–	1894‖	–	–	.51	8.13	1.98	.0312	[illegible]	.0199	.0046	0.95	.0257	.0010	.50	2.3
–	1895	–	–	.51	6.96	2.10	[illegible]	[illegible]	[illegible]	.0061	0.77	.0236	.0019	.59	1.9
–	1896	–	–	.47	6.16	1.95	.0217	.0293	.0224	.0069	0.66	.0155	.0019	.56	1.8

* Four samples on September 17. † Five samples in July and August. ‡ August and October.
§ August, October and November. ‖ July to December.

NOTE to analyses of 1896: Odor, generally musty; in August and September, vegetable. —— The samples were collected from the river at the railroad bridge, a short distance above its mouth.

NASHUA RIVER.

Chemical Examination of Water from the Quinepoxet River in Holden.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1896.														
15844	Jan. 6	Distinct.	Slight.	0.70	3.25	1.85	.0020	.0212	.0196	.0016	.16	.0130	.0000	0.69	0.5
16191	Mar. 3	Distinct, clayey.	Slight.	0.42	2.75	1.40	.0020	.0192	.0166	.0026	.09	.0030	.0000	0.55	0.0
16555	May 6	Distinct.	Cons.	0.90	3.40	1.30	.0014	.0228	.0146	.0082	.20	.0020	.0000	0.67	0.5
16918	July 2	V. slight	Slight.	0.45	4.30	1.85	.0010	.0266	.0218	.0048	.26	.0070	.0000	–	0.3
17362	Sept. 2	Distinct.	Slight.	0.38	3.85	1.40	.0004	.0358	.0312	.0046	.23	.0020	.0001	0.51	0.5
17809	Nov. 9	Slight.	Cons.	1.00	4.90	2.70	.0004	.0248	.0224	.0024	.21	.0000	.0001	1.12	0.9

Averages by Years.

–	1892	–	–	0.62	3.70	1.49	.0014	.0194	.0158	.0086	.19	.0068	.0001	–	0.9
–	1893*	–	–	0.72	3.75	1.57	.0004	.0192	.0160	.0032	.26	.0044	.0001	0.66	0.9
–	1894	–	–	0.61	3.85	1.47	.0041	.0214	.0171	.0043	.29	.0027	.0001	0.68	0.7
–	1895	–	–	0.77	4.47	1.97	.0020	.0289	.0239	.0050	.26	.0090	.0003	0.78	0.9
–	1896	–	–	0.64	3.74	1.67	.0012	.0250	.0210	.0040	.19	.0045	.0000	0.71	0.4

* August to December.

NOTE to analyses of 1896 Odor, vegetable. —— The samples were collected from the river at Smith's Woolen Mill in Holden, and 1,000 feet from the line between Holden and West Boylston.

Chemical Examination of Water from the Stillwater River in Sterling.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1896.														
15845	Jan. 6	V. slight	V. slight.	.68	3.20	1.45	.0004	.0156	.0144	.0012	.19	.0070	.0000	.60	0.5
16190	Mar. 3	Slight	Slight.	.40	2.25	0.90	.0012	.0172	.0158	.0014	.07	.0030	.0000	.51	0.2
16554	May 6	Distinct.	Slight	.60	3.10	0.95	.0012	.0186	.0172	.0014	.17	.0030	.0001	.60	1.6
16917	July 2	V. slight	Slight.	.36	3.65	1.50	.0010	.0210	.0192	.0018	.14	.0050	.0000	–	0.6
17361	Sept. 2	Distinct.	Cons.	.30	3.60	1.30	.0058	.0468	.0410	.0058	.21	.0000	.0001	.51	0.9
17808	Nov. 9	V. slight	V. slight.	.73	4.10	2.00	.0002	.0186	.0144	.0042	.17	.0030	.0001	.99	0.5

Averages by Years.

–	1892	–	–	.44	2.88	1.18	.0001	.0131	.0109	.0022	.13	.0072	.0000	–	0.9
–	1893*	–	–	.50	3.46	1.38	.0006	.0147	.0126	.0021	.18	.0022	.0001	.49	0.7
–	1894	–	–	.45	3.20	1.14	.0008	.0137	.0115	.0022	.18	.0017	.0000	.44	0.8
–	1895	–	–	.52	3.48	1.45	.0008	.0179	.0161	.0018	.19	.0051	.0000	.58	0.9
–	1896	–	–	.50	3.32	1.35	.0016	.0229	.0203	.0026	.16	.0035	.0000	.62	0.7

* August to December.

NOTE to analyses of 1896. Odor, vegetable. —— The samples were collected from the river at a highway bridge about 1 mile above the line between Sterling and West Boylston.

NASHUA RIVER.

Chemical Examination of Water from the South Branch of the Nashua River above Clinton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
15542	Jan. 6	Slight.	Slight.	.58	3.75	1.85	.0006	.0264	.0248	.0016	.16	.0090	.0000	.60	1.8
16169	Mar. 2	Decided, clayey.	Cons., earthy.	.46	2.60	0.90	.0042	.0216	.0154	.0064	.07	.0030	.0000	.48	0.6
16536	May 4	Slight.	Slight.	.40	3.05	0.90	.0038	.0156	.0142	.0014	.21	.0050	.0001	.42	1.1
16683	May 27	Slight.	Slight.	.35	3.20	1.00	.0032	.0152	.0126	.0026	.19	.0050	.0001	.34	0.9
[redacted]	July 1	Distinct.	Slight.	.35	3.90	1.60	.0018	.0174	.0136	.0038	.17	.0020	.0001	–	1.1
17346	Sept. 1	Slight.	V. slight.	.25	4.05	1.05	.0018	.0168	.0136	.0032	.21	.0020	.0001	.32	1.3
17541	Sept.22	Slight, milky.	Slight.	.45	2.95	1.40	.0044	.0280	.0248	.0032	.26	.0040	.0000	.56	1.8
17762	Nov. 2	V. slight.	Slight	.53	4.00	1.70	.0006	.0160	.0138	.0022	.26	.0050	.0001	.70	1.3

Averages by Years.

–	1887*	–	–	.58	4.14	1.24	.0016	.0210	–	–	.21	.0077	–	–	–
–	1888	–	–	.32	3.53	1.06	.0006	.0151	–	–	.18	.0097	.0001	–	–
–	1889†	–	–	.24	2.96	0.87	.0004	.0163	.0133	.0030	.18	.0062	.0002	–	–
–	1893‡	–	–	.41	3.99	1.42	.0006	.0158	.0129	.0029	28	.0020	.0001	.46	1.4
–	[redacted]	–	–	.44	3.81	1.27	.0014	.0154	.0123	.0031	.25	.0042	.0000	.42	1.1
–	1895	–	–	.46	4.00	1.44	.0017	.0226	.0189	.0037	.28	.0090	.0000	.53	1.3
–	1896§	–	–	.43	3.56	1.37	.0023	.0199	.0167	.0032	.18	.0045	.0000	.49	1.2

* June to December. † January to May. ‡ August to December.

§ Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1896: Odor, distinctly vegetable, occasionally mouldy.—The samples were collected from the river at the dam of the Lancaster Manufacturing Company.

NASHUA RIVER.

Chemical Examination of Water from the South Branch of the Nashua River, just above its Confluence with the North Branch at Lancaster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
15940	Jan. 23	Distinct.	Cons.	.35	4.45	1.50	.0066	.0168	.0138	.0030	.29	.0220	.0002	.51	1.3
16099	Feb. 19	Distinct, milky.	Slight.	.42	3.95	1.50	.0038	.0190	.0156	.0034	.16	.0180	.0001	.50	0.9
16283	Mar. 18	Distinct.	Slight.	.40	3.40	1.05	.0010	.0136	.0122	.0014	.20	.0180	.0002	.40	1.0
16466	Apr. 22	Distinct.	Slight.	.50	3.35	1.45	.0024	.0158	.0124	.0034	.15	.0170	.0001	.53	1.2
16648	May 20	Decided.	Cons., rusty.	.35	5.10	1.80	.0056	–	–	–	.39	.0080	.0007	.44	1.7
16835	June 18	Distinct, milky.	Cons., brown.	.53	5.90	2.10	.0316	.0342	.0296	.0046	.42	.0070	.0017	.44	1.6
17045	July 22	Distinct.	Slight, earthy.	.40	4.75	1.66	.0290	.0230	.0182	.0048	.40	.0050	.0015	.36	1.4
17252	Aug. 19	Distinct.	Slight.	.40	5.05	1.45	.0068	.0198	.0182	.0016	.54	.0070	.0006	.46	1.7
17489	Sept. 16	Distinct.	Cons., earthy.	.40	4.76	1.85	.0078	.0220	.0144	.0076	.33	.0050	.0004	.47	2.3
17694	Oct. 21	Slight.	Slight.	.53	5.45	2.30	.0042	.0226	.0216	.0010	[illegible]	.0160	.0005	.77	1.4
17899	Nov. 18	Distinct, milky.	Cons.	.60	5.30	2.00	.0024	.0260	.0180	.0080	.52	.0170	.0006	.68	1.8
18154	Dec. 27	Distinct, clayey.	Slight.	.50	5.15	1.80	.0094	.0258	.0242	.0016	.42	.0180	.0002	.65	2.1

Averages by Years.

–	1888*	–	–	.20	4.91	1.11	.0264	.0230	.0173	.0067	.28	.0192	.0008	–	–
–	1890†	–	–	.30	4.68	1.55	.0162	.0288	.0218	.0075	.31	.0104	.0008	–	1.7
–	1891‡	–	–	.45	6.01	2.22	.0141	.0338	.0242	.0096	[illegible]	.0093	.0008	–	1.6
–	1892§	–	–	.43	5.66	1.66	.0181	.0267	.0214	.0053	[illegible]	.0160	.0006	–	1.8
–	1894‖	–	–	.52	6.21	1.91	.0582	.0285	.0226	.0076	.57	.0095	.0017	[illegible]	1.8
–	1895	–	–	.53	4.66	1.77	.0167	.0238	.0185	.0053	.34	.0114	.0008	.61	1.4
–	1896	–	–	.45	4.72	1.69	.0094	.0216	.0180	.0036	.35	.0134	.0006	.53	1.6

* Four samples on September 17.
† Four samples in July and August.
‡ August and October.
§ August, October and November.
‖ July to December.

NOTE to analyses of 1896: Odor, generally musty and sometimes disagreeable; in August, vegetable. —— The samples were collected from the river at the Atherton bridge, a short distance above its mouth.

STONY BROOK.

Chemical Examination of Water from Stony Brook, Boston.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
17092	July 31	Distinct, milky.	Cons.	.35	11.35	2.60	.0152	.0344	.0212	.0132	1.68	.0800	.0050	.38	5.0
17284	Aug. 26	V. slight.	Slight.	.33	12.90	3.70	.0030	.0178	.0142	.0036	1.88	.0700	.0050	.50	5.2

Odor, vegetable or musty. —— The samples were collected from Stony Brook above the Forest Hills railroad station.

WARE RIVER.

Chemical Examination of Water from Ware River at Cold Brook Station, Barre

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1896.														
15839	Jan. 6	V. slight	Slight.	.90	3.60	1.75	.0000	.0194	.0182	.0012	.14	.0070	.0000	.89	0.6
16166	Mar. 2	Distinct, clayey.	Cons., earthy.	.43	2.80	1.15	.0004	.0202	.0152	.0050	.05	.0030	.0001	.62	0.2
16522	May 4	V. slight.	V. slight.	.72	2.80	1.20	.0000	.0176	.0164	.0012	.12	.0050	.0000	.62	0.6
16911	July 1	Slight.	Slight.	.70	3.25	1.45	.0004	.0200	.0184	.0016	.07	.0030	.0001	-	1.5
17351	Sept. 1	Distinct.	Slight.	.70	3.75	1.70	.0004	.0218	.0200	.0018	.13	.0050	.0000	.60	0.9
17784	Nov. 4	V. slight.	V. slight.	.90	3.95	1.85	.0004	.0198	.0178	.0020	.17	.0020	.0000	.91	0.6

Averages by Years.

-	1893*	-	-	.73	3.67	1.67	.0002	.0188	.0154	.0034	.15	.0000	.0000	.79	0.5
-	1894	-	-	.74	3.56	1.47	.0005	.0179	.0155	.0024	.14	.0023	.0000	.68	0.5
-	1895	-	-	.78	3.96	1.70	.0014	.0219	.0199	.0020	.17	.0051	.0000	.79	0.6
-	1896	-	-	.73	3.36	1.52	.0003	.0198	.0177	.0021	.11	.0038	.0000	.73	0.8

* August, November and December.

NOTE to analyses of 1896: Odor, distinctly vegetable and mouldy. —— The samples were collected from the river, at the railroad bridge, near Cold Brook station, in the south-easterly part of the town of Barre.

SUMMARY

OF

WATER SUPPLY STATISTICS;

ALSO

RECORDS OF RAINFALL AND FLOW OF STREAMS.

SUMMARY OF WATER SUPPLY STATISTICS.

During the year 1896 a public water supply was introduced for the first time into the towns of Hatfield, Rutland, Walpole, Weston and Winchendon, and a new supply was introduced into the town of Bradford to replace the former supply which had become objectionable, owing to the presence of an excessive amount of iron in the water. The following table gives a classification by population of cities and towns having and not having public water supplies Dec. 31, 1896. The populations are taken from the census of 1895: —

Population (1895).	Number of Places of Given Population having a Public Water Supply.	Total Population of Places in Preceding Column.	Number of Places of Given Population not having a Public Water Supply.	Total Population of Places in Preceding Column.
Under 500,	0	0	36	13,287
500-1,000,	4	3,301	55	42,503
1,000-1,500,	10	11,912	37	45,331
1,500-2,000,	8	13,825	31	53,651
2,000-2,500,	9	19,990	14	31,074
2,500-3,000,	7	19,867	11	29,624
3,000-3,500,	10	32,515	7	22,599
3,500-4,000,	5	18,219	1	3,569
4,000-4,500,	9	39,006	1	4,055
Above 4,500,	97	2,089,816	1	6,039
Totals,	159	2,248,451	194	251,732

From the totals given in the preceding table it will be seen that of the 353 cities and towns in the State, 159, or 45 per cent., have a public water supply, and the total population of the places supplied represents 89.93 per cent. of the total population of the State. The number of people to whom a public water supply is available is somewhat less than the total population of the municipalities supplied, but the difference is not large. There are now 10 towns

having, by the census of 1895, populations exceeding 3,000 which are not provided with a public water supply. These are given in the following table: —

Towns.	Population in 1895.	Towns.	Population in 1895.
Blackstone,	6,039	Pepperell,	3,321
Barnstable,	4,055	Dudley,	3,203
North Andover,	3,569	Chelmsford,	3,162
Sutton,	3,420	Dartmouth,	3,107
Tewksbury,	3,379	Deerfield,	3,007

In the following table the various water supplies are classified according to the dates when a fairly complete system was first introduced into a city or town: —

Years.	Number of Places supplied.	Years.	Number of Places supplied.
Previous to 1850,	6	1892,	1
1850-1859, inclusive,	4	1893,	3
1860-1869, inclusive,	10	1894,	3
1870-1879, inclusive,	44	1895,	5
1880-1889, inclusive,	68	1896,	5
1890,	5	Total,	159
1891,	5		

There has been no change in the ownership of any of the works during the past year. All of the 32 cities in the State having an aggregate population of 1,635,767 own their water works. Of the 127 towns having a public water supply, 81, with a total population of 398,395, own their works, while 47, having a total population of 214,289, are supplied by private companies. The total population in both cities and towns owning works is 2,034,162, against 214,289 in those supplied by private companies. The following table gives statistics with regard to the consumption of water in cities and towns of this State, where such records are kept. The consumption per inhabitant has been obtained by dividing the average daily consumption by the total population of the city in 1896, and, consequently,

is somewhat less than the amount used per consumer, because there are in all cities and towns some who do not use the public water supply. This difference is most marked in towns containing villages to which the public water supply has not been extended, and in towns where the works have been in operation but a short time and where water has not come into general use. In some towns the population during the summer months is much greater than is shown by census returns, and in such cases the consumption per inhabitant as given in the table is somewhat higher than it would be if allowance was made for the increased population in summer.

Statistics relating to the Consumption of Water in Various Cities and Towns.

City or Town.	Population. 1896.	Average Daily Consumption. Gallons. 1896.	Daily Consumption per Inhabitant. Gallons. 1896.
Abington and Rockland.	9,781	371,000	38
Attleborough,	8,430	316,000	38
Avon,	1,674	49,000	29
Ayer,	2,092	69,000	33
Beverly,	12,003	874,000	73
Boston (Cochituate Works).	481,700	56,302,000	117
Boston, Somerville, Chelsea, Everett (Mystic Works).	135,400	11,952,000	88
Bradford,	4,939	356,000	72
Braintree,	5,404	367,000	68
Bridgewater and E. Bridgewater.	7,664	168,000	22
Brockton,	34,339	1,087,000	32
Brookline,	16,976	1,348,000	79
Cambridge,	83,966	6,638,000	79
Canton,	4,656	175,000	38
Cohasset,	2,479	79,000	32
Cottage City,	1,030	71,900	70
Danvers,	8,326	599,000	72
Dedham,	7,229	500,000	69
Easton,	4,444	83,000	19
Fairhaven,	3,422	110,000	32
Fall River,	92,164	3,547,000	38
Foxborough,	3,276	158,000	48
Framingham,	9,567	376,000	39
Franklin,	5,197	214,000	41
Gardner,	9,334	517,000	55
Gloucester,	28,923	775,000	27
Grafton,	5,121	80,000	16
Holliston,	2,738	54,000	20
Hopkinton,	2,763	33,000	12
Hyde Park,	12,153	636,000	52
Ipswich,	4,776	74,000	15
Lawrence,	53,666	3,014,000	56
Lexington,	3,558	140,000	39
Longmeadow,	622	36,000	58
Lowell,	85,701	6,933,000	81
Lynn and Saugus,	68,341	4,539,000	67
Malden,	31,043	1,514,000	49
Manchester,	1,893	153,000	81
Mansfield,	3,780	127,000	34
Marblehead,	7,565	276,000	36
Marlborough,	15,211	548,000	36
Maynard,	3,168	72,000	23
Melrose,	12,654	777,700	61
Methuen,	5,865	170,000	29
Middleborough,	6,814	211,000	31
Milford,	8,995	640,000	71
Milton,	5,766	149,000	26
Montague,	6,010	382,000	64
Nantucket,	2,966	84,000	28

Statistics relating to the Consumption of Water in Various Cities und Towns — Concluded.

City or Town.	Population. 1896.	Average Daily Consumption. Gallons. 1896.	Daily Consumption per Inhabitant. Gallons. 1896.	City or Town.	Population. 1896.	Average Daily Consumption. Gallons. 1896.	Daily Consumption per Inhabitant. Gallons. 1896.
Natick, . . .	8,753	408,000	47	Sharon, . . .	1,734	42,000	24
Needham, . .	3,606	146,000	40	Stoughton, . .	5,356	247,000	46
New Bedford, .	58,155	5,259,000	91	Swampscott and Nahant.	4,133	414,000	100
Newburyport, .	14,673	613,000	42	Taunton, . . .	27,448	1,179,000	43
Newton, . . .	28,232	1,812,000	64	Tisbury, . . .	996	24,000	24
No. Attleborough, .	6,546	186,000	28	Wakefield and Stoneham.	14,878	688,000	46
North Brookfield, .	4,788	132,000	28	Walpole, . . .	3,072	59,000	19
Norwood, . .	4,742	308,600	65	Waltham, . .	21,310	1,522,000	72
Orange, . . .	5,519	150,000	27	Ware, . . .	7,715	232,000	30
Peabody, . .	10,577	927,000	88	Wareham, Onset Bay.	3,350	12,000	36
Provincetown, .	4,538	91,000	20	Watertown and Belmont.	10,923	532,000	49
Quincy, . . .	21,510	1,034,000	48	Webster, . .	7,953	233,000	29
Randolph and Holbrook.	5,906	287,000	49	Wellesley, . .	4,355	193,000	44
Reading, . . .	4,843	199,000	41	Weston, . . .	1,719	24,000	14
Revere and Winthrop.	12,259	936,000	76	Whitman, . .	6,005	231,000	39
Rockport, . .	5,529	172,000	31	Woburn, . . .	14,314	1,026,000	72
Salem, . . .	32,207	2,297,000	65	Worcester, . .	101,589	6,126,000	60

RAINFALL.

The rainfall for the year 1896 was 3.9 inches less than the normal, as shown by an average of the recorded rainfall at several stations in various parts of the State covering periods of many years. There was an excess of rainfall only in the months of February, March and September, the greatest excess being in September. The deficiency in rainfall was distributed throughout the remaining months, the greatest deficiency occurring in January, April, May, August, November and December. The distribution of rainfall was such as to cause a low flow in the streams in August, but the large rainfall in September caused the flow in the streams during the months of September and October to be above the normal. In the following table is given the normal rainfall in each month in 1896, and the departures from the normal:*—

	Normal Rainfall.	Rainfall, 1896.	Excess or Deficiency.		Normal Rainfall.	Rainfall, 1896.	Excess or Deficiency.
	Inches.	Inches.	Inches.		Inches.	Inches.	Inches.
1896.				1896.			
January,	3.88	1.97	−1.91	August,	4.31	2.63	−1.68
February,	3.67	4.85	+1.18	September,	3.37	6.67	+3.30
March,	4.00	5.90	+1.90	October,	4.00	3.60	−0.49
April,	3.31	1.41	−1.90	November,	4.03	2.99	−1.04
May,	3.66	2.54	−1.12	December,	3.56	1.76	−1.80
June,	3.25	2.96	−0.29				
July,	3.87	3.82	−0.05	TOTAL,	45.00	41.10	−3.90

To enable the conditions preceding the collection of samples of water in any portion of the State to be understood, the following tables are presented, which give the daily rainfall in inches at nine stations scattered throughout the State:—

* This and subsequent tables of rainfall have been prepared from the records of the New England Weather Service.

Daily Rainfall in Inches at Nine Places in Massachusetts, Geographically selected.

January, 1896.									
Day of Month.	Ludlow.	Amherst.	Fitchburg	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford
1,	–	–	–	–	–	–	–	–	–
2,	–	–	–	–	–	–	–	–	–
3,	–	–	–	–	–	–	–	–	0.06
4,	–	–	–	–	–	–	–	–	–
5,	–	–	–	–	–	–	–	–	–
6,	–	–	–	–	–	–	–	–	–
7,	0.15	0.15	0.09	0.19	0.16	0.09	*	*	*
8,	–	–	–	–	–	–	0.11	0.20	0.16
9,	0.17	*	0.23	*	*	*	*	*	*
10,	0.25	0.15	0.64	0.62	0.56	0.41	0.74	1.30	1.09
11,	–	–	–	–	–	–	–	–	–
12,	–	0.01	0.05	0.03	0.09	0.06	0.06	–	0.02
13,	–	–	–	–	–	–	–	–	–
14,	–	–	–	–	–	–	–	–	–
15,	–	–	–	–	–	–	–	–	–
16,	–	–	–	–	–	–	–	–	–
17,	–	–	–	–	–	–	–	–	–
18,	–	–	–	–	–	–	–	–	–
19,	–	0.09	–	*	0.07	–	*	*	–
20,	–	–	–	0.05	–	–	0.06	0.20	0.11
21,	–	–	–	–	–	–	–	–	–
22,	–	–	–	–	–	–	–	–	–
23,	–	–	–	–	–	–	–	–	–
24,	*	*	*	*	*	*	*	*	*
25,	0.85	*	1.46	1.51	0.81	*	1.66	1.36	0.75
26,	–	0.48	–	0.03	–	*	0.09	0.02	–
27,	–	–	–	–	–	1.05	–	–	–
28,	–	–	–	–	–	–	–	–	–
29,	–	–	–	–	–	–	–	–	–
30,	–	–	–	–	–	–	–	–	–
31,	–	–	–	–	–	–	–	–	–
Totals,	0.92	0.91	2.37	2.43	2.50	0.81	2.71	3.08	2.19

February, 1896.									
Day of Month.	Ludlow	Amherst.	Fitchburg	Framingham.	Chestnut Hill	Lawrence	Salem.	Taunton.	New Bedford.
1,	0.10	0.55	0.45	0.44	0.54	*	*	0.65	0.70
2,	–	–	–	–	–	0.74	0.86	–	–
3,	*	*	–	–	*	–	–	*	–
4,	0.06	*	*	–	*	*	0.05	*	0.16
5,	0.30	*	0.42	–	*	*	–	*	0.09
6,	1.35	*	3.06	2.30	2.57	*	0.16	*	*
7,	–	1.11	0.05	–	–	2.69	1.92	2.38	1.27
8,	*	*	–	–	–	–	–	–	–
9,	0.15	0.41	0.84	0.50	0.43	0.31	*	*	0.35
10,	–	–	–	–	–	–	0.47	0.40	–
11,	–	–	–	0.03	–	–	–	–	0.04
12,	–	–	–	–	–	–	–	–	–
13,	0.73	*	0.66	0.36	0.45	0.53	*	*	*
14,	–	0.66	–	–	–	–	0.55	0.76	0.05
15,	–	–	–	–	–	–	–	–	–
16,	–	–	–	0.06	0.12	–	0.20	0.05	0.02
17,	–	–	–	–	–	–	–	–	–
18,	*	*	–	*	0.10	*	*	*	0.02
19,	0.05	0.06	0.85	0.45	0.30	0.30	0.18	0.23	0.23
20,	–	–	–	–	–	–	–	–	–
21,	–	–	–	–	–	–	–	–	–
22,	–	–	–	–	–	–	–	–	–
23,	–	–	–	–	–	–	–	–	–
24,	–	–	–	–	–	–	–	–	–
25,	–	–	–	–	–	–	–	–	–
26,	–	–	–	–	–	–	–	–	–
27,	–	–	–	–	–	–	–	–	–
28,	–	*	–	–	–	–	–	–	–
29,	1.00	2.00	1.06	1.62	0.39	†	1.26	1.24	0.47
Totals,	3.74	4.77	6.93	5.65	5.45	5.57	5.64	5.67	4.38

* Precipitation included in that of following day. † 1.00, estimated.

Daily Rainfall in Inches at Nine Places in Massachusetts, Geographically selected — Continued.

March, 1896.

Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill	Lawrence.	Salem.	Taunton.	New Bedford.
1,	–	0.42	0.94	*	*	1.42	*	0.82	–
2,	–	–	0.30	1.06	1.73	*	0.57	0.60	–
3,	–	–	0.11	0.85	*	*	0.94	–	1.55
4,	–	–	0.10	0.30	0.10	0.64	–	–	*
5,	–	–	–	–	–	–	0.17	–	0.10
6,	–	–	–	–	–	–	–	–	–
7,	0.30	0.60	0.53	0.32	0.32	0.33	–	0.08	0.34
8,	–	–	–	–	–	–	–	–	–
9,	–	–	–	–	–	–	–	–	–
10,	–	–	–	–	–	–	–	–	–
11,	*	*	*	*	*	*	*	*	*
12,	0.18	0.50	0.25	0.70	0.40	0.30	0.47	0.55	0.62
13,	–	–	–	–	–	–	–	–	–
14,	–	–	–	–	–	–	–	–	–
15,	*	*	*	*	*	*	*	*	*
16,	0.30	1.00	*	*	*	*	0.47	1.20	*
17,	–	–	1.19	1.12	1.33	0.80	0.78	0.25	1.25
18,	–	*	–	–	–	–	–	–	–
19,	*	2.77	1.17	*	*	*	–	0.28	*
20,	2.50	–	0.10	1.05	0.66	0.81	–	–	0.12
21,	–	–	–	–	–	–	–	–	–
22,	–	–	–	–	–	–	–	–	–
23,	0.05	0.03	0.07	0.02	0.03	–	*	*	*
24,	–	–	–	–	–	–	0.03	0.22	0.22
25,	–	–	–	–	–	–	–	–	–
26,	–	0.12	0.01	–	–	–	–	–	–
27,	–	–	0.01	–	–	–	–	–	–
28,	–	–	–	–	–	–	–	–	–
29,	0.80	*	0.87	*	*	*	*	*	*
30,	0.15	1.08	0.18	0.90	0.98	1.06	1.06	1.28	1.62
31,	–	–	–	–	–	–	–	–	–
Totals,	5.23	6.52	5.51	5.21	5.53	5.36	4.49	5.79	5.82

April, 1896.

Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1,	–	*	–	–	–	–	–	–	*
2,	–	0.47	0.82	0.52	0.86	0.61	0.80	0.72	0.67
3,	0.55	–	–	–	–	–	–	–	–
4,	–	–	–	–	–	–	–	–	–
5,	–	–	–	–	–	–	–	–	–
6,	–	–	–	–	–	–	–	–	–
7,	–	–	–	0.08	0.05	–	*	*	0.04
8,	–	–	–	–	–	–	0.08	0.07	–
9,	–	–	–	–	–	–	–	–	–
10,	–	–	–	–	–	–	–	–	–
11,	–	–	–	–	–	–	–	–	–
12,	–	–	–	–	–	–	–	–	–
13,	–	–	–	–	–	–	–	–	–
14,	–	–	–	–	–	–	–	–	–
15,	–	–	–	–	–	–	–	–	–
16,	–	–	–	–	–	–	–	–	–
17,	0.50	–	0.11	*	*	*	*	0.14	0.21
18,	–	–	0.06	0.66	0.26	0.06	0.08	–	–
19,	0.15	0.30	0.29	0.29	0.43	0.10	*	–	0.02
20,	–	–	–	–	–	–	0.12	–	–
21,	–	*	0.10	*	*	*	*	*	–
22,	0.20	0.25	0.17	0.30	0.82	0.32	0.36	0.37	0.29
23,	–	–	–	–	–	–	–	–	–
24,	–	–	–	–	–	–	0.26	–	–
25,	–	–	–	–	–	–	–	–	–
26,	–	–	–	–	–	–	–	–	–
27,	–	–	–	–	–	–	–	–	–
28,	–	–	–	–	–	–	–	–	–
29,	–	–	–	–	–	–	–	–	–
30,	–	–	–	–	–	–	–	–	–
Totals,	1.40	1.02	1.05	1.55	1.72	1.09	1.70	1.30	1.23

* Precipitation included in that of following day.

Daily Rainfall in Inches at Nine Places in Massachusetts, Geographically selected — Continued.

May, 1896.									
Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1,	–	–	–	–	–	–	–	–	–
2,	–	–	–	–	–	*	–	–	–
3,	–	–	–	0.04	0.10	0.04	–	–	0.01
4,	–	–	–	–	–	–	–	–	–
5,	–	–	–	0.20	–	–	–	0.33	0.17
6,	–	–	–	–	–	–	–	–	–
7,	–	–	–	–	–	–	–	–	–
8,	–	–	–	–	–	–	0.04	–	–
9,	–	0.15	–	0.02	0.03	0.05	–	–	–
10,	–	–	–	–	–	–	–	–	–
11,	–	–	–	0.03	–	0.16	0.12	–	–
12,	–	–	–	–	–	–	0.07	–	–
13,	–	–	–	–	–	–	–	–	–
14,	–	–	–	–	–	–	–	–	–
15,	0.08	0.04	0.02	–	–	–	–	–	–
16,	–	–	–	–	–	–	–	–	–
17,	–	–	–	–	–	–	–	–	–
18,	–	–	–	–	–	–	–	–	–
19,	0.90	0.10	0.10	0.84	0.40	0.06	0.34	0.70	0.80
20,	–	–	–	–	–	–	–	–	–
21,	0.15	0.05	–	0.06	0.06	–	0.08	0.63	*
22,	–	–	–	–	–	–	–	–	0.72
23,	–	–	–	–	–	–	–	–	–
24,	–	–	–	–	–	–	–	–	–
25,	–	–	0.33	–	–	–	–	–	–
26,	0.30	0.20	–	0.14	0.16	0.55	0.34	0.33	0.37
27,	–	–	–	–	–	–	–	–	–
28,	*	0.73	0.55	*	*	*	*	*	*
29,	1.10	0.42	0.16	0.92	0.50	0.45	0.62	0.88	0.99
30,	*	–	–	–	–	–	–	–	–
31,	0.90	0.75	0.72	0.83	0.52	1.14	0.65	0.35	1.16
Totals,	2.60	2.46	1.90	2.90	1.35	2.43	2.16	3.22	3.62

June, 1896.									
Day of Month.	Ludlow	Amherst.	Fitchburg	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1,	–	–	–	–	–	–	–	–	–
2,	–	–	–	–	–	–	–	–	–
3,	–	–	–	–	–	–	–	–	–
4,	–	–	–	–	–	–	–	–	–
5,	–	–	–	–	–	–	–	–	–
6,	–	–	–	–	–	–	–	–	–
7,	0.40	0.20	0.21	*	*	*	0.30	*	*
8,	0.50	0.50	0.39	*	*	*	0.02	*	*
9,	–	0.04	–	0.70	0.79	0.80	0.37	0.95	1.65
10,	0.65	0.35	0.30	0.62	0.54	–	0.31	1.04	0.96
11,	–	–	–	–	–	–	–	–	–
12,	–	–	–	–	–	–	–	0.03	–
13,	–	–	–	–	–	–	–	–	–
14,	0.35	0.56	0.91	*	*	*	*	*	*
15,	–	–	–	1.65	1.53	0.63	1.54	1.40	1.31
16,	–	*	–	–	–	–	–	–	–
17,	–	0.37	0.12	0.07	0.09	–	–	–	0.01
18,	–	–	–	–	–	–	–	–	–
19,	–	–	–	–	–	–	–	–	–
20,	–	–	–	0.02	–	–	–	–	–
21,	0.15	0.36	0.22	0.06	–	0.27	0.06	–	–
22,	–	–	–	–	–	–	–	–	–
23,	–	–	–	–	–	–	–	–	–
24,	–	–	–	–	–	–	–	–	–
25,	–	–	–	–	–	–	–	–	–
26,	–	–	–	–	–	–	–	–	–
27,	–	–	–	–	–	–	–	–	–
28,	–	–	–	0.02	0.10	–	–	0.79	0.86
29,	–	–	–	–	–	–	–	–	–
30,	–	–	–	–	–	–	–	–	–
Totals,	2.45	2.46	2.25	3.14	3.05	1.49	3.30	4.21	[illegible]

* Precipitation included in that of following day.

Daily Rainfall in Inches at Nine Places in Massachusetts, Ge[illegible]ically selected — Continued.

July, 1896. Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1,	–	–	–	–	–	–	–	–	–
2,	–	1.08	–	–	–	–	–	–	–
3,	1.00	0.05	–	–	–	–	–	–	–
4,	*	0.20	–	*	*	*	–	*	–
5,	1.00	–	0.33	0.42	0.37	0.42	0.32	0.22	0.98
6,	–	*	–	*	*	–	–	–	–
7,	0.48	1.46	0.59	*	0.57	0.51	0.67	–	0.29
8,	–	–	–	0.22	–	–	0.01	0.13	–
9,	–	–	–	–	–	–	–	–	–
10,	–	–	–	–	–	–	–	–	–
11,	–	–	–	–	–	–	–	0.06	0.17
12,	–	–	–	–	–	–	–	–	–
13,	–	–	–	–	–	–	–	0.04	0.01
14,	–	–	–	–	–	–	–	–	0.11
15,	0.85	0.66	0.21	0.26	*	0.19	–	–	–
16,	0.20	0.02	–	0.24	0.98	–	0.20	0.16	0.33
17,	–	–	–	–	–	–	–	–	–
18,	–	–	–	–	–	–	–	–	–
19,	–	–	–	–	–	–	–	–	–
20,	0.40	0.50	0.32	*	*	*	*	*	0.02
21,	–	0.39	0.12	0.16	0.20	0.33	0.21	0.14	0.15
22,	–	–	–	–	–	–	–	*	*
23,	0.40	0.14	0.09	0.12	0.13	0.09	0.06	0.12	0.17
24,	–	0.25	0.15	*	*	*	*	*	*
25,	[illegible]	0.27	0.50	0.50	0.60	0.65	0.87	0.52	[illegible]
26,	–	–	–	–	–	–	–	–	[illegible]
27,	0.20	0.03	0.01	0.06	0.08	0.10	0.13	–	[illegible]
28,	–	–	–	–	–	–	–	–	[illegible]
29,	–	–	–	*	–	0.90	0.10	0.27	[illegible]
30,	0.75	0.55	0.22	0.14	0.12	0.15	0.16	0.06	[illegible]
31,	–	0.05	–	–	–	–	–	–	[illegible]
Totals,	5.78	5.87	2.57	2.14	[illegible]	3.32	2.73	[illegible]	[illegible]

Augu[illegible]96. Day of Month.	Ludlow.	Amherst.			Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1,	–	*	[illegible]	–	–	–	–	–	–
2,	–	[illegible]	[illegible]	[illegible]	0.90	0.82	0.99	0.88	1.00
3,	–	[illegible]	[illegible]	–	–	–	–	–	–
4,	–	[illegible]	[illegible]	–	–	–	–	–	–
5,	*	[illegible]	[illegible]	*	0.15	0.77	0.47	0.75	*
6,	0.20	[illegible]	[illegible]	1.28	0.51	–	0.14	0.39	0.39
7,	–	[illegible]	[illegible]	–	–	–	–	–	–
8,	[illegible]	[illegible]	–	–	–	–	0.28	–	–
9,	[illegible]	[illegible]	–	–	–	–	0.01	–	–
10,	[illegible]	[illegible]	–	–	–	–	–	–	–
11,	[illegible]	[illegible]	–	–	–	–	–	–	–
12,	[illegible]	–	–	–	–	–	–	0.48	–
13,	[illegible]	–	–	–	0.22	–	–	–	–
14,	[illegible]	0.76	–	0.05	–	*	–	0.15	0.34
15,	[illegible]	–	0.08	–	–	0.30	–	–	–
16,	[illegible]	0.22	0.01	0.06	–	–	–	*	*
17,	–	–	–	–	–	–	–	0.02	0.05
18,	–	0.06	0.09	0.05	0.33	*	0.07	0.31	0.08
19,	–	–	0.01	0.02	–	0.18	0.09	–	0.08
20,	–	–	–	–	–	–	–	–	–
21,	–	–	–	–	–	–	–	–	–
22,	0.15	–	0.08	0.10	0.18	0.25	0.05	0.09	0.06
23,	0.05	0.16	0.20	*	0.11	*	0.19	0.12	[illegible]
24,	0.10	0.45	0.33	0.10	0.03	0.30	0.08	0.25	0.08
25,	–	–	–	–	–	–	–	–	–
26,	–	–	–	–	–	–	–	–	–
27,	0.05	0.12	0.05	–	–	0.02	–	–	0.23
28,	–	–	–	–	–	–	–	–	–
29,	–	–	–	–	–	–	–	–	–
30,	–	–	–	–	–	–	–	–	–
31,	0.15	0.46	0.07	0.08	0.06	0.05	0.06	–	0.09
Totals,	1.32	3.50	2.29	2.74	2.74	2.69	3.37	3.37	3.56

* Precipitation [illegible] in that of following day.

Daily Rain, Inches at Nine Places in Massachusetts, Geographically selected — Continued

…ber, 1896.

Day of Month.	Ludlow.	Amherst.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1,	–	–	–	–	–	–	–	–
2,	–	–	–	–	–	–	–	–
3,	0.45	0.27	0.[illegible]	[illegible].48	0.70	*	0.97	*
4,	–	0.03	0.0[illegible]	–	–	0.47	–	0.65
5,	1.50	*	0.01	[illegible]	*	–	*	*
6,	0.50	2.86	2.07	2.[illegible]	2.71	2.64	0.64	0.43
7,	–	–	–		–	0.08	–	–
8,	–	–	–		–	–	–	–
9,	0.10	0.28	0.02	*	*	*	*	*
10,	–	–	0.79	1.27	[illegible]2	1.78	3.74	3.64
11,	–	–	–	–		–	–	–
12,	–	–	–	–		–	–	0.09
13,	–	–	0.26	*		–	–	*
14,	–	0.06	–	0.28	0.4[illegible]	–	0.05	0.21
15,	–	–	–	–	–	[illegible]	0.82	0.16
16,	–	–	–	–	–		*	–
17,	0.90	0.45	0.08	0.17	0.07	0.[illegible]	0.32	–
18,	–	–	–	–	–		–	0.14
19,	1.27	1.35	1.48	1.18	1.14	1.5[illegible]	[illegible]86	1.07
20,	–	0.06	0.03	–	–	–	[illegible]	0.71
21,	–	–	–	–	–	–	[illegible]	–
22,	0.30	0.22	0.16	0.09	0.07	0.14		0.22
23,	–	–	–	–	–	–		–
24,	–	–	–	–	–	–	–	–
25,	–	–	–	–	–	–	–	
26,	–	–	–	–	–	–	–	
27,	–	–	–	–	–	–	–	
28,	–	–	–	–	–	–	–	
29,	*	*	–	*	–	–	–	–
30,	0.85	0.62	1.17	0.92	0.83	0.86	0.68	0.77
Totals,	5.27	6.17	5.69	7.39	7.16	6.92	5.65	9.21

October, 1896.

Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1,	–	0.21	–	*	–	0.03	0.01	–	–
2,	–	–	0.10	0.06	0.06	–	*	*	*
3,	–	–	0.02	–	–	–	0.13	0.06	0.05
4,	*	*	0.06	*	*	–	*	–	0.13
5,	0.15	0.76	0.37	0.42	0.47	*	*	–	–
6,	0.96	0.11	0.12	0.06	*	0.27	*	0.85	0.66
7,	0.05	0.20	0.06	0.07	[illegible]	0.09	0.29	–	0.01
8,	–	–	–	–	–	–	–	–	–
9,	–	–	–	–	–	–	–	–	–
10,	–	–	–	–	–	–	–	–	–
11,	–	–	–	–	–	–	–	–	–
12,	–	0.07	–	*	*	*	–	–	0.02
13,	1.16	0.98	1.11	1.46	1.27	*	*	0.76	–
14,	*	0.02	0.07	–	–	0.99	0.96	–	0.67
15,	0.15	0.22	0.27	0.53	0.51	0.17	0.68	0.68	0.40
16,	0.06	–	–	–	–	–	–	–	–
17,	0.07	*	–	–	–	–	–	–	–
18,	–	0.30	0.10	0.06	0.14	0.15	*	–	–
19,	–	0.02	–	–	–	–	0.06	–	–
20,	–	*	–	–	–	–	–	–	–
21,	0.25	0.21	0.06	0.04	–	0.08	–	–	0.06
22,	–	–	–	–	–	–	–	–	–
23,	*	*	0.05	*	*	*	*	*	*
24,	0.85	0.75	0.48	1.06	1.02	0.82	1.18	1.12	1.66
25,	–	–	–	–	–	–	0.08	–	–
26,	–	–	–	–	–	–	–	–	–
27,	–	–	–	–	–	–	–	–	–
28,	–	–	–	–	–	–	–	–	–
29,	–	–	0.01	–	0.08	0.05	–	–	–
30,	–	*	–	0.05	–	0.02	*	–	–
31,	–	0.03	0.06	–	–	–	0.08	–	0.02
Totals,	3.68	3.86	2.92	3.54	3.49	2.66	3.29	3.86	3.46

* Precipitation include[illegible]t of following day.

Daily Rainfall in Inches at Nine Places in Massachusetts, Geographically selected — Concluded.

November, 1896.

Day of Month.	Ludlow.	Amherst.	Fitchburg	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1, .	–	–	–	–	–	–	–	–	–
2, .	–	–	–	–	–	–	–	–	–
3, .	–	–	–	–	–	–	–	–	–
4, .	–	*	–	*	–	*	–	–	–
5, .	1.06	1.26	1.69	1.08	1.05	0.67	*	–	*
6, .	–	–	0.06	–	–	–	1.10	1.80	1.19
7, .	–	–	–	–	–	–	–	–	–
8, .	–	0.03	–	0.14	0.50	0.17	0.08	0.71	*
9, .	–	–	–	–	–	–	–	–	0.06
10, .	–	–	–	–	–	–	–	–	–
11, .	0.08	0.16	0.10	0.09	0.06	0.11	–	0.15	0.05
12, .	–	–	–	–	0.08	–	–	0.06	0.18
13, .	–	–	–	0.15	*	*	*	*	0.06
14, .	–	–	–	–	0.32	0.27	0.06	0.17	0.19
15, .	–	–	–	–	–	–	–	–	–
16, .	–	–	–	–	–	–	–	–	–
17, .	–	–	–	–	–	–	–	–	–
18, .	–	–	–	–	–	–	–	–	–
19, .	–	–	–	–	–	–	–	–	–
20, .	–	–	–	–	–	–	–	–	–
21, .	0.30	*	0.39	*	*	*	*	*	*
22, .	–	0.27	–	0.39	0.48	0.38	0.88	0.60	0.30
23, .	–	–	–	–	–	–	–	–	–
24, .	0.05	–	0.01	0.06	0.05	–	–	–	–
25, .	0.06	0.62	–	*	–	–	*	*	–
26, .	0.25	–	0.32	0 30	0.30	*	0.45	0.07	0.03
27, .	–	–	–	–	–	0.46	–	–	–
28, .	*	0.42	0.09	*	*	*	*	–	*
29, .	0.47	0.12	0.28	0.50	0.56	0.33	0.58	–	0.88
30, .	0.10	–	0.06	0.22	0.28	0.13	0.21	0.62	0.35
Tot.,	2 38	2.87	3.00	2 92	3.61	2.81	3.96	3.87	2.93

December, 1896.

Day of Month.	Ludlow.	[redacted]	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1, .	–	–	–	–	–	–	–	–	–
2, .	–	–	–	–	–	–	–	–	*
3, .	–	–	–	–	–	–	–	–	0.06
4, .	–	–	–	0.06	–	0.08	–	–	*
5, .	–	–	–	–	0.02	–	–	–	0.15
6, .	–	–	–	–	–	–	–	–	–
7, .	–	–	–	–	–	–	–	–	–
8, .	0.96	*	0.06	*	*	*	–	*	*
9, .	0.15	0.64	1.08	1.01	0.98	1.21	1.14	0.82	1.12
10, .	–	–	–	–	–	–	–	–	–
11, .	–	–	–	–	–	–	–	–	–
12, .	–	–	–	–	–	–	–	–	–
13, .	–	–	–	–	–	–	–	–	–
14, .	–	–	–	–	–	–	–	–	–
15, .	–	–	–	*	–	–	–	–	–
16, .	–	0.08	0.39	0.73	0.47	0.40	0.58	1.25	*
17, .	–	–	–	–	–	–	–	–	1.40
18, .	–	0.02	–	0.08	0.12	0.04	0.08	0.09	*
19, .	–	–	–	–	–	–	–	–	0.08
20, .	–	–	–	–	–	–	–	–	–
21, .	–	–	–	–	–	–	–	–	–
22, .	*	*	–	–	*	–	–	*	*
23, .	0.25	0.18	0.20	0.30	0.30	0.04	0.25	1.14	0.87
24, .	–	–	–	–	–	–	–	–	–
25, .	–	–	–	–	–	–	–	–	–
26, .	–	–	–	–	–	–	–	–	–
27, .	–	–	–	–	–	–	–	–	–
28, .	–	–	–	–	–	–	–	–	–
29, .	–	–	–	–	–	–	–	–	–
30, .	–	–	–	–	–	–	–	–	–
31, .	–	–	–	–	–	–	–	–	–
Tot.,	1.35	0.87	1.69	2.17	1.89	1.74	1.97	3.30	3.68
Totals for the Year,	36 04	41.10	39.39	43.28	42.22	36.66	40.18	47.91	46.15

* Precipitation included in that of following day.

Flow of Streams.

The records of the flow of the Sudbury River for 1896 indicate that the flow of the streams of the State was slightly less than the average for the past twenty-two years. In order to show the relation between the flow of the Sudbury River during each month of 1896 and the normal flow of the same river, as deduced from observations covering a period of twenty-two years, from 1875 to 1896 inclusive, the following table has been prepared. The area of the watershed of the Sudbury River above the point where its flow was measured is 75.2 square miles.

Table showing Average Monthly Flow of Sudbury River for the Year 1896, in Cubic Feet per Second per Square Mile of Drainage Area, also Departures from the Normal Flow.

MONTH.	Normal Flow. — Cubic Feet per Second per Square Mile.	Actual Flow in 1896. — Cubic Feet per Second per Square Mile.	Excess or Deficiency. — Cubic Feet per Second per Square Mile.
January,	1.865	1.676	—0.189
February,	2.914	4.140	+1.226
March,	4.442	5.931	+1.489
April,	3.138	2.312	—0.826
May,	1.721	0.556	—1.165
June,	0.726	0.617	—0.109
July,	0.283	0.147	—0.136
August,	0.426	0.088	—0.338
September,	0.380	0.599	+0.219
October,	0.846	0.915	+0.069
November,	1.450	1.019	—0.431
December,	1.579	1.015	—0.564
Average,	1.641	1.577	—0.064

The next table shows the weekly fluctuations during 1896 in the flow of the two streams most carefully measured, namely, the Sudbury and the Merrimack. The flow of these streams, particularly the Sudbury, will serve to indicate the condition of the other streams in eastern Massachusetts.

Week ending Sunday. 1896.	Sudbury River. Cubic Feet per Second per Square Mile.	Merrimack River. Cubic Feet per Second per Square Mile.	Week ending Sunday. 1896.	Sudbury River. Cubic Feet per Second per Square Mile.	Merrimack River. Cubic Feet per Second per Square Mile.
Jan. 5, ...	2.712	2.961	July 5, ...	—0.033	0.390
12, ...	1.204	1.369	12, ...	0.152	0.468
19, ...	1.054	1.118	19, ...	0.487	0.415
26, ...	1.832	0.909	26, ...	0.182	0.461
Feb. 2, ...	2.278	0.793	Aug. 2, ...	0.095	0.455
9, ...	6.862	2.494	9, ...	0.289	0.484
16, ...	3.700	2.864	16, ...	0.009	0.488
23, ...	1.839	1.509	23, ...	0.004	0.398
Mar. 1, ...	4.461	1.518	30, ...	0.026	0.413
8, ...	9.550	8.471	Sept. 6, ...	0.243	0.389
15, ...	3.057	2.676	13, ...	1.000	0.846
22, ...	6.436	3.177	20, ...	0.603	0.669
29, ...	4.742	4.169	27, ...	0.387	0.770
Apr. 5, ...	5.156	4.555	Oct. 4, ...	0.491	0.603
12, ...	2.851	2.961	11, ...	0.589	0.718
19, ...	1.962	5.487	18, ...	1.237	1.312
26, ...	1.717	3.881	25, ...	1.075	1.518
May 3, ...	0.907	1.857	Nov. 1, ...	0.966	1.250
10, ...	0.697	1.277	8, ...	1.149	1.862
17, ...	0.369	0.912	15, ...	1.059	1.695
24, ...	0.488	0.677	22, ...	0.647	1.016
31, ...	0.556	0.730	29, ...	1.074	1.161
June 7, ...	0.475	0.886	Dec. 6, ...	1.102	1.268
14, ...	0.776	0.917	13, ...	1.563	1.269
21, ...	1.383	0.743	20, ...	0.993	0.887
28, ...	0.277	0.534	27, ...	0.758	0.648

In the report for the year 1895 the weekly flow of the Sudbury River was incorrectly given. The following table gives the corrected figures for that year: —

Week ending Sunday. 1895.	Flow of Sudbury River. Cubic Feet per Second per Square Mile.	Week ending Sunday. 1895.	Flow of Sudbury River. Cubic Feet per Second per Square Mile.
Jan. 6, ...	0.586	July 7, ...	0.307
13, ...	2.000	14, ...	0.304
20, ...	1.969	21, ...	0.206
27, ...	1.658	28, ...	0.161
Feb. 3, ...	1.385	Aug. 4, ...	0.767
10, ...	1.000	11, ...	0.487
17, ...	0.801	18, ...	0.101
24, ...	0.729	25, ...	0.606
Mar. 3, ...	1.091	Sept. 1, ...	0.213
10, ...	2.458	8, ...	0.068
17, ...	5.818	15, ...	0.245
24, ...	3.146	22, ...	0.136
31, ...	4.072	29, ...	0.051
Apr. 7, ...	2.863	Oct. 6, ...	0.120
14, ...	4.144	13, ...	0.561
21, ...	6.878	20, ...	6.223
28, ...	2.380	27, ...	1.265
May 5, ...	1.632	Nov. 3, ...	2.366
12, ...	1.030	10, ...	2.704
19, ...	1.230	17, ...	3.544
26, ...	0.705	24, ...	5.330
June 2, ...	0.673	Dec. 1, ...	5.554
9, ...	0.490	8, ...	3.487
16, ...	0.407	15, ...	1.969
23, ...	—0.447	22, ...	2.117
30, ...	0.527	29, ...	3.321

In the annual report of the State Board of Health for the year 1890, pages 338 to 340, a table taken from the annual reports of the Boston Water Board was printed, giving the records of rainfall upon the Sudbury watershed, and its total yield expressed in inches in depth on the watershed (inches of rainfall collected) for the sixteen years from 1875 to 1890 inclusive. The corresponding records for the years 1891 to 1895 inclusive were given in the annual report in 1895, page 430. In the following table is given the record for 1896, together with the average of the records for the whole twenty-two years: —

Rainfall received and collected on the Sudbury River Watershed.

Month.	1896.			Mean for 22 Years, 1875-1896.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	2.390	1.933	80.88	4.237	2.151	50.77
February,	7.180	4.466	62.20	4.275	3.065	71.70
March,	5.235	6.841	130.68	4.414	5.121	116.02
April,	1.570	2.579	164.27	3.259	3.501	107.42
May,	2.575	0.641	24.89	3.377	1.984	58.75
June,	3.220	0.689	21.40	2.901	0.810	27.92
July,	2.510	0.170	6.77	3.707	0.327	8.82
August,	2.395	0.102	4.26	4.126	0.491	11.90
September,	7.720	0.669	8.67	3.242	0.425	13.11
October,	3.765	1.055	28.02	4.521	0.975	21.57
November,	3.020	1.137	37.65	4.085	1.618	39.61
December,	2.125	1.171	55.11	3.605	1.820	50.49
Totals and averages,	43.705	21.458	49.09	45.748	22.288	48.72

The Sudbury River records are particularly valuable as a basis for estimating the yield of other watersheds in Massachusetts, both on account of the accuracy with which the measurements have been made, and the absence of abnormal conditions which would unfavorably affect the results. It is, therefore, thought advisable to publish in the following table those portions of the records relating to the yield of this watershed for each of the twenty-two years, and in doing so the flow from the watershed is expressed in gallons per day per square mile instead of inches, and the depth of rainfall collected, in order to render the table more convenient for use in estimating the probable yield of other watersheds.

*Yield of the Sudbury River Watershed in Gallons per Day per Square Mile.**

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.
January,	103,000	645,000	658,000	1,810,000	700,000	1,121,000	416,000	1,241,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000	2,408,000
March,	1,604,000	4,435,000	4,813,000	3,507,000	2,330,000	1,874,000	4,004,000	2,839,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,168,000	1,546,000	867,000
May,	1,188,000	1,139,000	1,391,000	1,394,000	1,114,000	514,000	965,000	1,292,000
June,	870,000	222,000	597,000	506,000	413,000	176,000	1,338,000	529,000
July,	321,000	183,000	202,000	128,000	168,000	177,000	276,000	86,000
August,	896,000	405,000	121,000	475,000	395,000	119,000	148,000	55,000
September,	207,000	184,000	60,000	160,000	141,000	90,000	197,000	306,000
October,	646,000	254,000	652,000	516,000	71,000	101,000	186,000	299,000
November,	1,302,000	1,068,000	1,418,000	1,693,000	206,000	205,000	395,000	210,000
December,	684,000	454,000	1,289,000	3,177,000	462,000	175,000	776,000	314,000
Average for whole year,	972,000	1,135,000	1,214,000	1,452,000	894,000	678,000	979,000	862,000
Av. for driest six months,	574,000	384,000	502,000	532,000	220,000	143,000	350,000	211,000

MONTH.	1883.	1884.	[redacted]	1886.	1887.	1888.	1889.	1890.
January,	335,000	995,000	1,235,000	1,461,000	2,580,000	1,053,000	2,782,000	1,254,000
February,	1,033,000	2,842,000	1,354,000	4,800,000	2,829,000	1,951,000	1,195,000	1,529,000
March,	1,611,000	3,765,000	1,572,000	2,059,000	2,868,000	3,237,000	1,339,000	3,643,000
April,	1,350,000	2,863,000	1,815,000	1,947,000	2,620,000	2,645,000	1,410,000	1,875,000
May,	938,000	1,030,000	1,336,000	720,000	1,009,000	1,632,000	880,000	1,366,000
June,	300,000	417,000	426,000	203,000	414,000	422,000	653,000	568,000
July,	115,000	224,000	62,000	115,000	114,000	117,000	633,000	108,000
August,	78,000	257,000	240,000	94,000	214,000	380,000	1,432,000	182,000
September,	91,000	44,000	121,000	118,000	111,000	1,165,000	824,000	458,000
October,	186,000	83,000	336,000	146,000	190,000	1,999,000	1,230,000	2,272,000
November,	205,000	175,000	1,178,000	673,000	866,000	2,758,000	1,941,000	1,215,000
December,	193,000	925,000	1,174,000	1,020,000	643,000	3,043,000	2,241,000	997,000
Average for whole year,	533,000	1,129,000	901,000	1,067,000	1,164,000	1,697,000	1,383,000	1,285,000
Av. for driest six months,	145,000	200,000	391,000	223,000	234,000	953,000	944,000	747,000

MONTH.	1891.	1892.	1893.	1894.	1895.	1896.	Mean for 22 Years, 1875-1896, inclusive.
January,	3,018,000	1,870,000	433,000	893,000	1,034,000	1,084,000	1,206,000
February,	3,466,000	943,000	1,542,000	991,000	541,000	2,675,000	1,860,000
March,	4,453,000	1,955,000	3,245,000	2,238,000	2,410,000	3,835,000	2,871,000
April,	2,397,000	871,000	2,125,000	1,640,000	2,515,000	1,494,000	2,028,000
May,	582,000	1,259,000	2,883,000	840,000	636,000	360,000	1,112,000
June,	414,000	428,000	440,000	419,000	174,000	399,000	469,000
July,	149,000	214,000	158,000	161,000	251,000	95,000	183,000
August,	163,000	280,000	181,000	209,000	229,000	57,000	276,000
September,	203,000	229,000	106,000	150,000	89,000	368,000	247,000
October,	210,000	126,000	221,000	374,000	1,379,000	592,000	547,000
November,	305,000	697,000	810,000	[redacted]	2,777,000	659,000	937,000
December,	644,000	485,000	797,000	716,000	1,782,000	657,000	1,020,000
Average for whole year,	1,315,000	781,000	1,037,000	770,000	1,152,000	1,019,000	1,060,000
Av. for driest six months,	239,000	327,000	237,000	356,000	456,000	314,000	394,000

* The area of the Sudbury River watershed used in making up these records included water surfaces amounting to about 1 per cent. of the whole area, from 1875 to 1878 inclusive, and subsequently increasing by the construction of storage reservoirs to about 3 per cent. in 1886. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

EXPERIMENTS

UPON THE

PURIFICATION OF SEWAGE AND WATER

AT THE

LAWRENCE EXPERIMENT STATION,

DURING THE YEAR 1896.

EXPERIMENTS UPON THE PURIFICATION OF SEWAGE AND WATER AT THE LAWRENCE EXPERIMENT STATION.*

By HARRY W. CLARK, Chemist in Charge.

The year 1896 is the ninth that the investigations of the Lawrence Experiment Station have been continued. The work has been carried on under the general supervision of Hiram F. Mills, A.M., C.E., a member of the State Board of Health, with the writer in direct charge. Mr. W. R. Copeland is in charge of the biological department and Mr. F. B. Forbes is assistant chemist. Mr. E. F. Badger and Mr. S. De M. Gage are assistants in the chemical and biological departments respectively. Dr. Thomas M. Drown is consulting chemist.

SEWAGE PURIFICATION.

The investigations upon the subjects of sewage and water purification have, during 1896, added much valuable data to the store of information which the Board has been accumulating during the past nine years.

The principal sewage filters which were constructed at the beginning of these investigations have been in operation during the past year. The continued systematic analyses of the applied sewage and effluents, occasional analyses of the filtering materials themselves, and the various observations in regard to their method of operation add continually to our knowledge of the permanency of sewage filters of different materials, and of the best means to maintain this permanency under different conditions. A number of new experiments have been begun for the purpose of gaining information upon subjects of increasing importance in sewage disposal, including the proper and economical disposition of the waste liquors or sewage

* A full account of the work done at the Lawrence Experiment Station for the years 1888 and 1889 is contained in a special report of the State Board of Health upon the Purification of Sewage and Water, 1890. A similar account for the years 1890 and 1891 is contained in the twenty-third annual report of the Board for the year 1891. Since 1891 the results have been published yearly in the annual reports.

from those manufacturing industries in the State which pollute or threaten to pollute our rivers and ponds.

In connection with the study of permanency, investigations of different methods of separating the sludge of the sewage from the main body of the liquid, and thus disposing of the clogging matters which tend to shorten the life of sewage filters, have been continued.

Methods for hastening and increasing the purifying action of filters by different means of increasing the air supply are of considerable scientific and practical interest, and experiments on these subjects have been continued throughout the year.

In addition to the chemical and mechanical examinations of filtering materials in use at the station, a large number of soils and sands from the following places have been examined during the year, either in connection with applications made to the Board for advice with reference to sewerage systems and water supplies or in connection with the Neponset River investigation: Norwood, East Walpole, Canton, Taunton, Provincetown, Danvers Lunatic Hospital, Rutland, Stockbridge and Leicester.

Purification of Manufacturing Sewage.

Various industries produce a large volume of waste liquor or sewage. It can be stated that the volume of sewage turned out daily by one manufacturing plant is often as great as the sewage of a village of considerable population, and the organic matters contained in manufacturing sewage are often much greater than in the same volume of town sewage.

These excessive amounts of organic matters, together with various chemicals used in the manufacturing processes and also present in the sewage, often render the problem of successful and economical disposal of this sewage exceedingly difficult.

During the past year the composition and disposal of the sewage of two tanneries, engaged in different lines of work, three paper mills and two wool-scouring establishments have been studied.

Tannery No. 1.

This tannery is engaged in preparing and tanning calf skins. Of these skins large numbers are imported, and, to prevent decomposition en route, come packed in sulpho naphthol, a germicide, and

this has been present in the sewage throughout the period of examination.

To aid in the process of freeing the skins of hair, a ton or more of sulphide of arsenic is used each month, mixed with lime to form a soluble salt of arsenic, and as a result of this the sewage always contains arsenic in suspension and solution. Various other chemicals and dyes are used in the tannery and are present in the sewage.

The sewage as it flows from the tannery is a heavy, thick and offensive liquid, containing a very large amount of organic matter and generally colored by the dyestuffs present in it. A large amount of the organic matter present is in suspension, and experiments have shown that it will settle out from the main body of the sewage very completely in one hour, this rapid sedimentation being aided by the lime and other chemicals in the sewage.

There is generally enough arsenic in this sewage to prevent or almost prevent the growth of bacteria, and hence if it were applied directly to filtration areas the bacterial actions, which cause the purification of sewage and upon which the life and value of a sewage filter depend, could not take place. A considerable proportion of the arsenic is held by the sludge, or organic matter in suspension, and is carried downward with it when the sewage is allowed to stand and settle. The supernatant sewage, after this sedimentation, contains, however, generally enough arsenic to check bacterial action, and if applied to filtration areas there would probably be an accumulation of arsenic in the filter in the course of time in sufficient quantity to permanently check nitrification.

The volume of sewage flowing from the tannery generally exceeds 200,000 gallons daily, and its character is shown by the following monthly averages of the chemical analyses of a large number of samples.

In regard to the bacteria in this sewage the numbers given in this table are of those present in the supernatant sewage, samples for planting being taken without shaking the bottle. The reason of this way of recording the numbers present is that if the bottle were shaken, and the sample planted contained its proportionate amount of the sludge, this sludge generally contained enough arsenic to sterilize the plate and prevent bacterial growth. This was particularly true of the samples collected during the last six months of the year.

Sewage of Tannery No. 1.

[Parts per 100,000.]

Date — 1896.	Ammonia.				Organic Nitrogen (Kjeldahl).		Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Albuminoid.							
	Free.	Total.	In Solution.	In Suspension.	Total.	In Solution.			
April,	0.7000	1.68	1.24	0.44	-	-	16.80	20.00	-
May,	0.8700	3.75	1.41	2.34	9.49	-	46.76	42.40	8,103,000
June,	2.2040	6.14	3.03	3.11	10.67	5.36	76.11	62.64	5,167,000
July,	4.0000	7.38	3.59	3.79	15.92	7.55	69.38	114.75	10,460
August,	3.8400	8.56	5.39	3.17	14.16	6.78	74.13	126.25	17,633
September,	1.2133	9.47	2.15	7.32	22.66	3.22	20.15	99.67	2,866
October,	1.3150	4.66	2.47	2.19	9.68	4.27	42.03	66.50	2,000
November,	1.9000	8.66	2.88	5.78	27.15	9.62	63.55	102.25	2,000
December,	0.3000	1.03	0.52	0.51	3.60	3.15	7.84	7.90	45,000
Average,	1.8158	5.70	2.52	3.18	14.17	5.71	46.31	71.37	1,668,730

Removal of Arsenic by Coke or Iron.

Methods for removing this arsenic have been studied, and we have found that by passing the sewage through a filter or strainer of coke breeze it is quite completely freed from the arsenic. This removal is probably due to a combination of the arsenic with the iron in the coke and the formation of an insoluble double salt of iron and arsenic which is retained in the coke. The same result is accomplished by passing the sewage through iron filings or turnings.

These methods of removing arsenic are important and can undoubtedly be applied in the case of other arsenic-bearing manufacturing sewages.

Average Amount of Arsenic (AS_2O_3) in Entire and Supernatant Sewage and Effluent of the Coke Strainer.

[Parts per 100,000.]

In entire tannery sewage,	8.5447
In supernatant tannery sewage,	1.6757
In effluent of coke strainer,	.0823

Much of the effluent of the coke strainer contained no arsenic, but occasionally, when an excessive amount was applied and the strainer was overworked, some would pass through.

Examination of the coke proved that a large percentage of the arsenic was retained in the upper few inches of the strainer. Thus, for example, a small filter containing 2 feet in depth of coke breeze was put in operation October 1 and flooded each day for two weeks with this sewage. The effluent was examined each day and contained no arsenic, and on October 15 the coke itself was examined with the following result: —

Arsenic ($AS_2\ O_3$).

[Parts per 100,000.]

In upper 4 inches of coke,	36.40
In middle 4 inches of coke,	6.60
In lower 4 inches of coke,	.20

Filtration of the Sewage of Tannery No. 1.

Two sand filters and the coke strainer before mentioned have been operated, receiving the supernatant sewage, and are designated as filters Nos. 71, 72 and 73.

Filter No. 71.

This filter contains 4.5 feet of sand of an effective size of 0.23 millimeter and has received the supernatant sewage at the rate of 50,000 gallons per acre daily. It has produced a satisfactory effluent generally, but nitrification has been entirely destroyed in it at those periods when the applied sewage has contained rather more arsenic than usual, as during September and again during December, as shown by the table beyond. In warm summer weather nitrification is quickly re-established in a filter, but if it ceases in winter it does not start again until warmer weather returns, thus causing poor purification and excessive storage of organic matter in a filter during the cold weather.

Filter No. 72.

This filter contains 2 feet in depth of coke breeze and has received the supernatant sewage at the rate of 100,000 gallons per acre daily. This rate kept the surface of the coke flooded for about two hours daily and could have been increased and still resulted in the removal of the arsenic. It has removed considerable organic matter and generally all the arsenic from the sewage. The object of this filter has been to free the sewage of germicides and thus get it into such a condition that the organic matter can be attacked by the bacteria of

decomposition, putrefaction and nitrification. That this result is accomplished is shown by the tables beyond, for when the sewage applied to this coke strainer or filter has contained so much arsenic that only a few hundred bacteria per cubic centimeter were found growing in it, its effluent has contained several million per cubic centimeter.

Filter No. 73.

This filter, containing 4.5 feet of sand of an effective size of 0.23 millimeter, has received the effluent of Filter No. 72 at the rate of 100,000 gallons per acre daily, and has maintained uniformly good nitrification and purification.

The following tables give the monthly averages of the analyses of the effluents of these three filters: —

Effluent of Filter No. 71.

[Parts per 100,000.]

Date — 1896.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid.		Nitrates.	Nitrites.		
May,	0.2600	.1120	27.30	0.9780	.2300	3.16	1,283,000
June,	0.0743	.0551	113.71	1.0660	.0094	4.56	1,294
July,	0.0576	.1736	84.78	3.6284	.0112	6.56	31,300
August,	1.3125	.2750	58.03	2.4655	.0925	7.08	22,500
September,	2.3900	.5660	90.12	0.0812	.0280	11.04	2,528,000
October,	0.3700	.1300	22.43	2.3820	.0380	2.40	153,000
November,	0.1533	.3000	53.67	0.8620	.0920	5.40	200,000
December,	1.2500	.2200	2.84	0.0320	.0000	3.50	495,000
Average,	0.7335	.2290	56.61	1.4369	.0626	5.46	589,260

Effluent of Filter No. 72 (Coke).

[Parts per 100,000.]

Date — 1896.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid.		Nitrates.	Nitrites.		
May,	0.4200	0.1193	27.08	.1690	.0192	2.33	662,000
June,	0.5008	0.3980	48.51	.3487	.0200	7.79	1,491,000
July,	3.8600	1.2640	78.68	.4290	.0120	17.88	2,523,000
August,	6.3000	0.9525	68.03	.0610	.0015	17.15	979,000
September,	4.3840	0.5240	77.10	.1266	.0068	8.64	2,808,000
October,	1.8667	0.3067	22.73	.1720	.0747	4.50	2,013,000
November,	1.7000	1.4800	49.60	.2360	.2200	11.90	20,170,000
December,	0.5200	0.1900	4.42	.0400	.0180	3.20	4,850,000
Average,	2.4439	0.6543	52.02	.1978	.0465	9.17	4,437,000

Effluent of Filter No. 73.

[Parts per 100,000.]

Date — 1896.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid.		Nitrates.	Nitrites.		
May,	.1526	.0729	31.29	0.9066	.2070	1.26	3,000
June,	.0330	.0368	31.66	0.6935	.0023	1.07	5,700
July,	.0556	.1476	91.22	3.1320	.0004	4.23	345,500
August,	.0725	.1175	64.98	3.8825	.0000	4.25	118,700
September,	.8160	.2344	114.42	3.7960	.0180	5.20	147,900
October,	.0120	.0605	25.33	2.2775	.0015	1.85	48,000
November,	.0127	.0720	56.63	1.9900	.0000	2.77	14,000
December,	.0280	.0820	17.58	1.2500	.0000	5.80	18,000
Average,	.1478	.1030	54.14	2.2410	.0287	3.30	87,600

Bacterial Analyses of the Sewage applied to and Effluents of Filters Nos. 71, 72 and 73.

[Bacteria per Cubic Centimeter in Sewage and Effluents.]

Month — 1896.	Sewage for Filters Nos 71 and 72.	Effluent of Filters Nos.		
		71.	72.	73.*
May,	8,103,000	1,283,000	662,000	3,000
June,	5,167,000	1,294	1,491,000	5,700
July,	10,460	31,300	2,523,000	345,500
August,	17,633	32,500	979,000	118,700
September,	2,866	2,528,000	2,808,000	147,900
October,	2,000	153,000	2,013,000	48,000
November,	2,000	200,000	20,170,000	14,000
December,	45,000†	495,000	4,850,000	18,000

* Filter No. 73 receives the effluent of Filter No. 72. † One analysis made in December.

Tannery No. 2.

Studies in regard to composition and methods of disposal of the sewage of a tannery engaged in preparing and tanning sheep skins were begun during the latter part of 1895 and have been continued during 1896. The sewage of this tannery varies in daily volume

from 20,000 to 50,000 gallons, and is a heavy liquid varying in color from time to time and having an exceedingly offensive odor. It seldom contains any substance of a character to check bacterial action, and the large amount of organic matter present is in an advanced state of decomposition and hence readily attacked by the bacteria in a filter. The sludge is at times great in volume as compared with the sludge of ordinary town sewage and very rich in fats and nitrogenous matters.

The following table gives the monthly averages of the chemical analyses of the sewage of this tannery: —

Sewage of Tannery No. 2.

[Parts per 100,000.]

Date — 1896.	Ammonia.				Organic Nitrogen (Kjeldahl).	Chlorine.	Oxygen Consumed.
		Albuminoid.					
	Free.	Total.	In Solution.	In Suspension.			
January,	2.40	2.65	1.46	1.19	–	1004.6	100.9
February,	3.27	3.50	2.86	0.64	–	[illegible]	68.0
March,	1.46	1.23	0.77	0.46	–	433.8	43.6
April,	4.30	5.39	4.23	1.66	–	343.8	27.7
May,	2.07	1.53	0.97	0.56	–	618.7	97.3
June,	4.10	2.25	0.96	1.29	3.678	262.0	56.9
July,	7.62	3.28	1.96	1.32	5.602	262.8	52.0
August,	7.50	3.46	2.27	1.21	6.273	316.8	66.3
September,	6.07	4.25	1.63	2 62	7.090	506.8	[illegible]
October,	8.75	4 88	2.85	2.03	6.505	252.0	48.2
November,	3.00	3.76	2.37	1.39	6.690	728.3	122.1
December,	2.02	1.74	1.06	0.66	5.321	234.0	[illegible]
Average,	4.38	3.16	1.91	1.25	5.920	462.4	67.5

A filter to which this sewage has been applied was in operation from September, 1895, until November, 1896. The filter contained 26 inches in depth of sand, of an effective size of 0.14 millimeter, over gravel underdrains, and during the first few weeks of its operation nitrification was active and its effluent of an entirely satisfactory character. It was being operated at this time at a rate of about 120,000 gallons per acre daily. After a short period, however, it

became badly clogged, owing to the large amount of sludge in the applied sewage and its accumulation upon the surface of the filter.

This sludge was of a gelatinous character when wet, and excluded the necessary air from the pores of the filter; when dry it was, as might be expected, of a leathery nature and would crack and separate into small pieces, and when removed would crumble into a powdery mass and remain in this condition, producing no offensive odor.

It is probable that, with a continual removal of this dry sludge from the filter's surface, good nitrification would have continued, although the depth of sand in the filter was not sufficient to obtain the best results. The filter has been operated during 1896 at an approximate rate of 25,000 gallons per acre daily, and has removed a large percentage of the organic matter from the sewage, but nitrification has not been active.

The following table gives the monthly averages of the analyses of the effluent of this filter: —

Effluent of Large Filter.

[Parts per 100,000.]

Date — 1896.	Ammonia.				Organic Nitrogen (Kjeldahl).	Chlorine.	Nitrogen as		Oxygen Consumed.
	Free.	Albuminoid.							
		Total.	In Solution.	In Suspension.			Nitrates.	Nitrites.	
January,	2.50	.61	.28	.33	-	389.5	.4000	.0000	23.00
February,	3.00	.26	.19	.07	-	276.8	.0440	.0000	7.50
March,	2.60	.15	.09	.06	-	222.0	.1410	.0040	3.25
April,	2.87	.28	.15	.13	-	268.2	.0505	.0040	5.53
May,	3.07	.51	.33	.18	-	312.5	.1820	.0200	12.40
June,	2.82	.29	.16	.13	0.691	255.2	.4352	.0027	6.68
July,	3.06	.21	.14	.07	0.355	266.1	.0588	.0005	3.43
August,	4.03	.67	.32	.35	1.449	340.5	.0983	.0000	18.00
September,	2.68	.28	.16	.12	0.550	227.0	.0170	.0011	2.10
October,	2.86	.19	.14	.05	0.398	226.8	.1463	.0025	1.45
Average,	2.95	.35	.20	.15	0.689	278.5	.1573	.0035	8.33

This filter was discontinued in November and an examination of the sand at that date showed the following amounts of nitrogen stored at different depths: —

Nitrogen.

[Parts per 100,000 by weight of dry sand.]

Surface,	632
6 inches down,	32
18 inches down,	21

Supernatant Sewage of Tannery No. 2.

A considerable percentage of the organic matter in suspension in this sewage can be removed by sedimentation, this being aided by the lime and other chemicals used in the tannery and present in the sewage.

The following table gives the monthly averages of the chemical analyses of the supernatant sewage: —

Supernatant Sewage of Tannery No. 2.

[Parts per 100,000.]

Date — 1896.	Ammonia.				Organic Nitrogen (Kjeldahl).	Chlorine.	Oxygen Consumed.
		Albuminoid.					
	Free.	Total.	In Solution.	In Suspension.			
January,	2.15	1.35	0.68	0.67	–	653.3	91.50
February,	2.48	1.24	0.49	0.75	–	525.5	63.00
March,	3.16	2.63	0.75	1.88	–	504.3	47.60
April,	5.40	4.16	1.98	2.17	–	605.8	35.70
May,	3.60	3.73	3.19	0.54	–	328.4	38.30
June,	4.00	2.35	1.88	0.47	4.235	445.5	130.30
July,	7.63	2.63	2.25	0.38	4.307	276.5	28.30
August,	7.07	1.10	0.78	0.32	1.661	591.3	36.00
September,	10.30	2.42	1.52	0.90	4.957	354.6	22.75
October,	6.00	1.90	1.33	0.57	3.237	227.4	41.25
November,	8.70	1.78	1.11	0.67	4.403	245.3	11.30
December,	7.60	[illegible]	2.61	0.38	3.749	189.0	14.00
Average,	5.68	2.40	1.55	0.85	4.536	380.8	50.74

In January a filter was started to receive this supernatant sewage. This filter contains 4 feet in depth of sand of an effective size of 0.14 millimeter, and is located in a building where the temperature is only slightly above the freezing point during the winter. As a result of this low temperature nitrification did not begin to be active until the

approach of warm weather. Sewage was applied for four months at the rate of 120,000 gallons per acre daily, but this rate was excessive for so strong a sewage and was reduced to 60,000 and then to 30,000 gallons per acre daily. Since the first of May nitrification has been exceedingly active and the effluent of the filter clear and practically odorless.

The following table gives the average analyses of the effluent, and a study of this table will show that much of the nitrogen stored in the filter during the pre-nitrification period has passed away in the effluent since the period of active nitrification began:—

Effluent of Filter receiving Supernatant Tannery Sewage.

[Parts per 100,000.]

Date — 1896.	Ammonia.				Organic Nitrogen (Kjeldahl).	Chlorine.	Nitrogen as		Oxygen Consumed.
	Free.	Albuminoid.					Nitrates.	Nitrites.	
		Total.	In Solution.	In Suspension.					
January,	1.85	.60	.55	.05	-	794.0	0.3580	.0040	36.00
February,	2.58	.76	.73	.03	-	751.3	0.1580	.0180	69.50
March,	3.53	.27	.24	.03	-	442.5	0.2580	.0410	3.30
April,	3.77	.28	.26	.02	-	358.0	0.1793	.0570	8.80
May,	4.48	.30	.28	.02	.836	334.3	2.0050	.1150	2.35
June,	4.88	.24	.18	.06	.525	406.9	2.9065	.1300	5.05
July,	0.98	.18	.16	.02	.210	265.0	8.3000	.0800	1.37
August,	2.35	.17	.14	.03	.330	615.0	8.1875	.0805	2.33
September,	1.11	.16	.13	.03	.271	414.5	9.9425	.0850	1.28
October,	1.18	.14	.11	.03	.191	309.6	10.2025	.0100	0.85
November,	1.82	.12	.09	.03	.333	273.0	9.4950	.0140	0.86
December,	1.52	.13	.08	.05	.235	254.0	12.1250	.0160	0.76
Average,	2.50	.28	.25	.03	.304	434.8	4.9264	.0542	11.04

Filter No. 75.

In order to prove decisively whether or not the sludge of this sewage really contained a substance which was prejudicial to nitrification, or whether the poor nitrification in the filter receiving the entire tannery sewage was due simply to the amount of sludge applied to it, a third filter was started, to receive a mixture of this sewage and ordinary city sewage. The filter contains 4.5 feet of

sand of an effective size of 0.23 millimeter and has been in operation since June 9.

It received during its first six weeks of operation equal quantities of the two sewages at a total rate of 50,000 gallons per acre daily. The amount of sludge was so great, however, that the surface of the filter became clogged, and the sewage applied was changed so that it contained one part of tannery sewage to two and one-half parts of Lawrence sewage.

Following this change nitrification became, and has continued to be, active and the effluent of the filter has been clear and odorless, thus showing that sewage, such as produced by this tannery, can be mixed with ordinary town or city sewage and successfully purified upon a common filtration area.

The following table gives the monthly averages of the analyses of the effluent of this filter: —

Effluent of Filter No. 75.

[Parts per 100,000.]

Date — 1896.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid.		Nitrates.	Nitrites.		
June,	.2545	.0350	126.83	0.6838	.1380	0.42	58,000
July,	.1116	.0524	112.72	0.8432	.1120	0.90	22,800
August,	.7515	.0745	98.48	0.9155	.3543	1.24	31,000
September,	.0260	.0464	104.85	5.1220	.0018	0.38	14,200
October,	.0183	.0527	91.67	6.1767	.0001	0.33	31,000
November,	.0160	.0520	82.87	5.2973	.0010	0.43	3,200
December,	.4028	.0528	67.78	3.6176	.0602	0.49	9,725
Average,	.2251	.0523	97.81	3.2366	.0939	0.60	24,275

Conclusions.

The results already obtained by these investigations into the character of tannery sewage and the possibility of disposing of it and destroying its offensive constituents upon the same general principles by which ordinary town sewage is purified are important, and furnish a basis for the study of the disposal of the sewage of tanneries producing waste liquors of a still different nature.

It seems probable that few tanneries produce a sewage more difficult to handle than that of Tannery No. 1, and in cases of this nature, where chemicals inimical to bacterial life are in the liquors, economical methods of removing them can probably be found.

Waste Liquors from Paper Mills.

The studies in regard to the character and disposal of waste liquors from paper mills have been continued.

These liquors can be divided into two classes, namely, those produced in washing and preparing the stock and those produced in making this stock into paper. Both liquors contain a large amount of organic matter, but the nitrogenous organic matter, principally the dirt washed from the stock, is most abundant in the first. The organic matter in the second liquor is largely of a carbonaceous nature, being the fine pulp which passes through the paper machine. A large amount of various kinds of chemicals is used in cleaning and bleaching the stock and often a large amount of dyestuffs in working the stock up into colored paper. In many mills, also, a clear almost colorless water is needed, and filters for clarifying the water by means of alum as a coagulant are used, and when these filters are cleaned the hydrate of alumina and dirt gathered in the filter are washed into the drain pipes of the mill.

Thus the waste liquors contain both dirt, fibre and chemicals, and a paper mill of ordinary capacity will turn several tons of solid matter into its waste pipes each day.

A large percentage of this waste is of such a character that it will gather in masses, but a large percentage is also in solution, and the volume of waste liquor is very great, that of the mills from which most of our samples for analysis have been taken varying from 2,000,000 to 3,000,000 gallons daily. This great volume, together with the character imparted to it by the chemicals present, makes the problem of satisfactory treatment difficult.

The three following tables present the average analyses of a large number of samples taken from the three waste pipes of paper mill No. 1. In regard to these analyses it can be stated here that at times, when the alum filters are being washed or when the rotary boilers are being emptied, the water running to waste is much more polluted than shown by any of the averages presented.

Waste Water from Drain No. 1.

[Parts per 100,000.]

Date — 1896.	Ammonia.				Chlorine.	Oxygen Consumed.
	Free.	Albuminoid.				
		Total.	In Solution.	In Suspension.		
June,	.0200	.0740	.0570	.0170	0.43	1.74
July,	.0135	.0788	.0443	.0345	0.84	2.15
August,	.0140	.0707	.0400	.0307	1.17	3.16
September,	.0150	.1254	.0605	.0649	0.86	3.35
October,	.0475	.1315	.0535	.0780	1.38	4.54
November,	.0195	.1140	.0549	.0591	1.11	4.84
December,	.0620	.2900	.2030	.0870	1.10	7.56
Average,	0303	.1263	.0733	.0530	0.98	3.88

Waste Water from Drain No. 2.

[Parts per 100,000.]

Date — 1896.	Ammonia.				Chlorine.	Oxygen Consumed.
	Free.	Albuminoid.				
		Total.	In Solution.	In Suspension.		
June,	.0100	.0580	–	–	1.24	1.35
July,	.0115	.0768	.0575	.0193	0.70	1.62
August,	.0080	.0600	.0400	.0200	1.71	1.25
September,	.0083	.0747	.0435	.0312	0.63	1.82
October,	.0528	.0841	.0653	.0188	2.54	2.73
November,	.0140	.1480	.1180	.0300	2.03	3.66
December,	.0180	.1040	.0670	.0370	1.05	3.75
Average,	.0175	.0865	.0652	.0261	1.41	2.30

Waste Water from Drain No. 3.

[Parts per 100,000.]

Date — 1896.	Ammonia.				Chlorine.	Oxygen Consumed.
	Free.	Albuminoid.				
		Total.	In Solution.	In Suspension.		
June,	.0230	.1780	.1060	.0720	0.59	4.10
July,	.0112	.0555	.0247	.0308	1.00	1.69
August,	.0075	0685	.0590	.0095	1.30	3.27
September,	.0287	.2060	.1113	.0947	0.70	4.67
October,	.0553	.1683	.1013	.0670	1.13	4.16
November,	.0200	.1460	.0940	.0520	1.42	5.10
December,	0220	.0910	.0580	.0330	1.24	4.05
Average,	.0245	.1805	.0792	.0513	1.05	3.85

Paper Mill No. 2.

The waste pipes of paper mill No. 2 all empty into a raceway underneath the mill. A large number of samples have been taken from this raceway, but their analyses do not accurately represent the waste liquor of the mill, owing to the fact that a large amount of water other than that used in the processes of manufacture in the mill comes into the raceway.

Other tables are given, however, presenting the average analyses of samples taken directly from the waste pipes.

From Raceway of Paper Mill No. 2.

[Parts per 100,000.]

Date — 1896.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Ammonia. Albuminoid. In Suspension.	Chlorine.	Oxygen Consumed.
June,	.0230	.0720	.0560	.0160	1.73	1.47
July,	.0087	.0720	.0567	.0153	1.03	1.75
August,	.0140	.0600	.0500	.0100	3.98	2.60
September,	.0110	.0785	.0450	.0335	1.44	2.77
October,	.0115	.0625	.0535	.0090	1.42	2.54
November,	.0120	.1280	.1000	.0280	1.12	8.10
Average,	.0134	.0788	.0602	.0188	1.79	3.21

From Washers and Beaters of Paper Mill No. 2.

[Parts per 100,000.]

Date — 1896.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Ammonia. Albuminoid. In Suspension.	Chlorine.	Oxygen Consumed.
November,	.0407	.3400	.1653	.1747	5.16	16.77
December,	.0300	.1400	.0900	.0500	0.75	6.20
Average,	.0354	.2400	.1277	.1124	2.96	11.49

Waste Water from Rotary Boilers of Paper Mill No. 2.

[Parts per 100,000.]

Date — 1896.	Ammonia.	Albuminoid.			Chlorine.	Oxygen Consumed.
	Free.	Total.	In Solution.	In Suspension.		
November,	1.1000	2.9000	-	-	187.0	220.0
December,	1.2000	2.2000	2.1000	[illegible]	130.6	[illegible]
Average,	1.1500	2.5500	2.1000	[illegible]	168.8	211.5

Waste Water from Paper Machines of Paper Mill No. 2.

[Parts per 100,000.]

Date — 1896.	Ammonia.	Albuminoid.			Chlorine.	Oxygen Consumed.
	Free.	Total.	In Solution.	In Suspension.		
October,	.0200	.0920	.0840	.0080	1.23	6.60
November,	.0210	.0720	.0890	.0330	[illegible]	5.60
December,	.0180	[illegible]	.0160	.0200	0.75	1.60
Average,	.0197	.0667	.0463	.0203	3.32	4.53

Waste Water from "Save All" at Paper Mill No. 2.

[Parts per 100,000.]

Date — 1896.	Ammonia.	Albuminoid.			Chlorine.	Oxygen Consumed.
	Free.	Total.	In Solution.	In Suspension.		
October,	.0120	.0240	.0200	.0040	2.82	1.92
November,	.0130	.0260	.0190	.0070	2.34	1.50
December,	.0160	[illegible]	[illegible]	.0220	1.28	1.44
Average,	.0137	.0300	.0190	.0110	2.15	1.62

This last table represents the liquor of the previous table after having passed through a screening apparatus in use at this mill. This apparatus is used to save as much of the pulp that has passed

through the paper machine as possible, and, as shown by the table, 55 per cent. of the organic matter represented by the albuminoid ammonia and 64 per cent. as represented by the oxygen consumed is screened out by this "save all."

Filter No. 77.

A mixture of these paper mill liquors has been applied to a small filter at the station. This filter contains 4.5 feet of sand of an effective size of 0.23 millimeter and was put in operation during June. The liquor is applied at the rate of 200,000 gallons per acre daily, and a bright, clear effluent, containing very little organic matter, has been obtained; but this purification is apparently caused by the straining out and retention in the filter of the organic matter applied. Some of the organic matter removed from the sewage has undoubtedly passed into the air in gaseous forms of carbon and nitrogen, but nitrification did not become active, although the experiment was carried on during the warmest months of the year, owing, probably, to the various chemicals in the applied liquor. It is possible that a larger percentage of the applied nitrogen passes into the air than is the rule with sand filters receiving ordinary town sewage, and that a filter receiving this liquor could be operated indefinitely. It is certainly true that a large percentage of the carbonaceous organic matter is strained out and left upon or very near the surface of the filter and can be removed without removing much of the filtering material. In order to keep a filter in successful operation this would probably have to be removed from time to time or thoroughly broken up at intervals, as it decomposes very slowly.

Effluent of Filter No. 77.

[Parts per 100,000.]

Date — 1896.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.
	Free.	Albuminoid.		Nitrates.	Nitrites.	
June,	.0140	.0280	1.17	-	.0060	.42
July,	.0113	.0213	0.96	.0153	.0059	.23
August,	.0093	.0220	1.47	.0117	.0003	.32
September,	.0068	.0240	1.77	.0052	.0000	.37
October,	.0014	.0142	1.17	.0060	.0000	.38
Average,	.0086	.0219	1.31	.0096	.0024	.34

Coke Strainer for Paper Liquor.

As has been mentioned previously, the volume of waste liquors turned out by the paper mills is very large, and as their pollutions are not offensive in the same manner and degree with town sewage, a partial purification which will remove a large percentage of the polluting matters, especially those in suspension, may be in many cases sufficient.

The use of coke as a filtering or straining medium through which to pass sewage at a high rate for the purpose of removing the matters in suspension has been investigated at the station. Its advantages are many, among which is that of removing the surface layer of coke and burning it when it becomes clogged by the sludge removed from the sewage.

In order to test the value of coke in treating these paper liquors a small coke strainer was started at the station, to which they were applied at the rate of 1,000,000 gallons per acre daily. The effluent of this strainer has been very satisfactory, as shown by the following table.

During December the strongly alkaline and highly polluted liquor from the rotary boilers (see page 442) was applied to this strainer.

Effluent of Filter No. 77 A.

[Parts per 100,000.]

DATE — 1896.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.
	Free.	Albuminoid.		Nitrates.	Nitrites.	
October, ...	.0263	.0198	2.03	.0088	.0038	0.35
November, ...	.0060	.0424	2.17	.0040	.0000	1.39
December, ...	.2000	.6200	35.00	.0140	.0100	44.00
Average, ...	.0774	.2274	13.07	.0089	.0046	15.25

Screening, Sedimentation and Chemical Precipitation.

A considerable proportion of the organic pollution of these liquors is, as has been said before, in suspension, and is quite readily removed by passing the liquid through wire screens. In some mills a considerable part of the fine pulp which passes through the paper machines is saved in this way, and it is evident that a large portion of

the dirt contained in the wash waters could be screened out in the same manner. If this were done it is evident that the resulting liquor could be applied to a coke strainer at two or three times as great a rate as would be feasible without this straining.

Results upon sedimentation are that about 30 per cent. of the total organic pollutions are removed from these liquors when they are allowed to stand and settle for one hour, and that a period of sedimentation two or three times as long improves this result little if any. This proportion of removal can be increased to about 45 per cent., if either ferrous or aluminum sulphate is added in proportion of 500 pounds per 1,000,000 gallons of liquor treated.

Waste Liquors from Rinsing and Scouring Wool.

The liquor resulting from scouring and rinsing wool is large in volume, exceedingly rich in organic and mineral matters in suspension and solution, and is of a character not readily acted upon by the agents of decomposition, putrefaction and nitrification.

The liquor of two wool-scouring works has been analyzed frequently during the year and studies and investigations made of methods for their disposal. From one of these plants samples of the scouring liquor itself, and from the other, samples of the entire mixed scouring and rinsing liquor, have been obtained for analysis and investigation.

Beginning in September, 1895, the waste scouring liquor was applied to a sand filter, but the excessive quantity of dirt and fats of various kinds in the liquor caused such a clogging of the surface of the filter that it was soon evident the clogging matters must be removed in some other way than by filtration. Consequently the percentage of removal of these fats and dirts by means of different chemicals has been investigated, and it has been found that the addition of calcium chloride to the liquor causes the formation of a lime soap, and that the fats and dirt in suspension, together with some of the matters in solution, are precipitated. The ordinary precipitants, such as lime and ferrous and aluminum sulphate, have little or no effect upon the liquor. The supernatant liquor, after removing fats, etc., by calcium chloride, is a clear, yellow liquid, containing very little matter in suspension. Its odor is slight and not at all offensive, and it does not change its character on standing. It contains a large amount of organic matter in solution, but, judging from the experiments thus far made, the indications are that it might be

allowed to enter a body of water not used as a water supply without creating a nuisance, as the decomposition of its organic matter would be very gradual.

The following table gives the average monthly analyses of the liquor after its treatment with calcium chloride: —

Wool-scouring Liquor after Treatment with Calcium Chloride.

[Parts per 100,000.]

Date — 1896.	Ammonia.		Organic Nitrogen (Kjeldahl).	Chlorine.	Nitrogen as		Oxygen Consumed.
	Free.	Albuminoid.			Nitrates.	Nitrites.	
May,	9.40	2.96	–	1040	.1940	.0000	27.40
June,	14.92	6.72	–	1009	.1732	.0060	53.26
July,	23.90	10.57	–	1239	.2560	.0015	96.06
August,	11.76	9.22	22.533	625	.2416	.0002	71.56
September,	26.33	16.39	27.386	2004	.2640	.0006	115.25
October,	5.37	6.72	15.766	1775	.3420	.0040	61.00
Average,	15.61	9.12	21.896	[illegible]	.2451	.0020	70.89

Experiments upon the feasibility of further purification of this liquor have been carried on and it has been applied to sand and coke filters, and although its clogging properties have been removed by its preliminary treatment so that it passes through the sand or coke at reasonable rates of filtration its character is improved but little. (See page 503, report of 1895.) When applied to a filter in a state of active nitrification it quickly checks and destroys this action, owing, probably, to its degree of alkalinity.

Beginning May 11, this clarified liquor was neutralized and applied to a filter containing 4.5 feet of sand of an effective size of 0.23 millimeter. The rate of filtration was at first 100,000 gallons per acre daily; on August 15 it was reduced to 25,000 and on September 11 to 12,500 gallons per acre daily. At either of these rates the applied liquor was easily disposed of but passed through the filter without material change, as shown by the following table of analyses of the effluent from this filter. The numbers of bacteria in both the applied liquor and effluent have varied from several hundred thousand to several million.

This filter went out of operation at the beginning of November.

Effluent of Filter No. 74.

[Parts per 100,000.]

DATE — 1896.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.
	Free.	Albuminoid.		Nitrates.	Nitrites.	
May,	9.16	6.51	895	.4666	.0318	30.85
June,	14.71	4.68	1084	.1641	.0013	45.00
July,	26.68	10.29	1264	.2698	.0000	105.30
August,	8.61	4.28	507	.5135	.0000	48.68
September,	31.06	12.12	1907	.2390	.0000	90.40
October,	8.80	2.64	1650	.1410	.0000	23.00
Average,	16.50	6.75	1218	.2990	.0055	57.21

Filter No. 76.

Experiments in regard to the ability of the clarified liquor to nitrify when neutralized and mixed with Lawrence sewage have been made. During June a filter containing 4.5 feet of sand of an effective size of 0.23 millimeter was put in operation, receiving equal volumes of the liquor and sewage at a total rate of 100,000 gallons per acre daily. This proportion and rate were continued until August 10, when, as nitrification had not started, the rate was reduced to 50,000 gallons per acre daily and the proportion changed so that the dose applied to the filter contained three parts Lawrence sewage to one part clarified and neutralized wool liquor. This change did not result in allowing nitrification to become established, and on September 11 the proportion was made one to five. Following this change, nitrification, in excess of that which could be accounted for by the change of the organic matter of the Lawrence sewage alone, has taken place and the effluent of the filter has been clear and almost odorless.

The following table gives the average monthly analyses of the dose applied during the period of nitrification, and the second table beyond presents the average monthly analyses of the effluent of the filter: —

Sewage applied to Filter No. 76.

[Parts per 100,000.]

Date — 1896.	Ammonia.		Organic Nitrogen (Kjeldahl).	Chlorine.	Nitrogen as		Oxygen Consumed
	Free.	Albuminoid.			Nitrates.	Nitrites.	
October,	3.25	11.20	26.855	1800.0	.4235	.0030	88.50
November,	5.13	9.45	24.116	1803.3	.2550	.2575	73.50
December,	4.95	1.19	4.731	235.8	.1273	.0015	7.10
Average,	4.44	7.28	18.567	1279.7	.2686	.0873	56.37

Effluent of Filter No. 76.

[Parts per 100,000.]

Date — 1896.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed
	Free.	Albuminoid.		Nitrates.	Nitrites.	
June,	9.8500	2.1700	513.8	0.2240	.0010	38.00
July,	14.3000	4.0200	654.3	0.1228	.0000	35.90
August,	7.4000	0.9390	97.5	0.2158	.0615	8.08
September,	9.9200	1.5720	350.5	0.4528	.1872	13.04
October,	1.9500	0.4575	211.1	2.3128	.4700	4.35
November,	1.1533	0.4733	[illegible]	4.8033	.3600	4.42
December,	0.4540	0.2880	214.7	4.1300	.7300	3.26
Average,	6.4368	1.4185	324.4	1.7516	.1728	15.29

Wool-scouring Plant No. 2.

The waste wool liquor previously described was that resulting simply from the scouring process. This waste scouring liquor is small in volume when compared with the entire waste liquor turned out by a wool-scouring plant, as the volume of water used in rinsing and washing the wool after it is scoured is many times as great as the volume used in the scouring process, — approximately 100 to 1, — and this entire waste liquor contains, of course, much less organic matter, volume for volume, than the scouring liquor alone.

Samples of this entire mixed scouring and rinsing liquor have been collected from the waste drain of a second wool-washing plant and analyzed.

The following table gives an average of these analyses : —

Waste Liquor of Wool-scouring Plant No. 2.

[Parts per 100,000.]

Date — 1896.	Ammonia.		Organic Nitrogen (Kjeldahl).	Chlorine.	Nitrogen as		Oxygen Consumed.
	Free.	Albuminoid.			Nitrates.	Nitrites.	
June,	0.0627	0.1813	–	1.03	.0333	.0000	1.53
July,	0.0355	0.3405	–	1.03	.0410	.0003	2.71
August,	0.3468	1.0255	1.0814	8.29	.0480	.0003	2.79
September,	0.3285	0.2350	0.4256	2.43	.0440	.0007	1.53
October,	0.7480	0.2416	0.4521	4.25	.0414	.0002	1.75
November,	1.2875	0.5025	1.3940	4.10	.0498	.0007	3.23
December,	0.9500	0.3225	1.3826	3.52	.0633	.0015	2.23
Average,	0.5441	0.4070	0.9471	3.42	.0465	.0005	2.25

Filter No. 70.

Beginning in June this liquor was applied to a filter containing 4.5 feet of sand of an effective size of 0.23 millimeter, at a rate of 100,000 gallons per acre daily. This rate of filtration continued until September 14, and while the applied dose was readily disposed of by the filter, and its effluent quite clear and generally odorless, nitrification did not become established. On September 14 the dose was so changed that it consisted of 5 parts wool liquor and 1 part Lawrence sewage, and the rate of application was made 120,000 gallons per acre daily. Following this change nitrification became and has remained active.

The following table presents the average monthly analyses of the effluent : —

Effluent of Filter No. 70.

[Parts per 100,000.]

Date — 1896.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid.		Nitrates.	Nitrites.		
June,	.0078	.0077	0.57	.0285	.0000	0.16	31,000
July,	.0352	.2226	8.10	.0652	.0000	3.53	46,000
August,	.0057	.0527	0.46	.0825	.0000	0.63	61,000
September,	.0307	.0273	1.45	.3610	.0006	0.42	38,000
October,	.0085	.0219	2.43	.6627	.0002	0.34	32,000
November,	.0028	.0423	2.09	.6260	.0000	0.58	48,000
December,	.0865	.0438	3.10	.7370	.0024	0.56	44,000
Average,	.0246	.0598	2.60	.3590	.0004	0.92	45,000

SOLID MATTERS IN MANUFACTURING WASTES.

The solid matters in the manufacturing sewages studied are large in amount. In the sewage from the calf-skin tannery the average amount of solids present in parts per 100,000 has been 932. As this tannery turns out from 200,000 to 300,000 gallons of sewage daily, it must contain at least 10 tons of solid matter daily. The solids in the sewage from the sheep-skin tannery are about the same, and, calling the average daily flow of sewage at this tannery 35,000 gallons, at least 1 ton of solid matter daily is carried away in the sewage. The solids in the wool-scouring liquor average 4,486 parts in 100,000. The average solids in the paper-mill waste liquors are 40 parts in 100,000, and, calling the average volume of the waste liquors 2,500,000 gallons daily, it appears that at least 4 tons of solid matter are contained in the daily flow.

FATS IN MANUFACTURING SEWAGES.

The tannery sewages and wool liquors are exceedingly rich in fatty matters. At some tanneries the fats pressed from the skins are saved, rendered and used as a dressing for the finished leather. The fats in the wool-scouring liquor consist of the soap used in the process and the animal fats removed from the wool. These fatty matters are almost universally wasted in this country, flowing away in the exhausted scouring liquor, but abroad they are very generally recovered and placed upon the market under the name of "degras." This fat is extensively used, especially in the leather industries, and a large amount is imported by this country. Whether its production in this country would be profitable or not cannot of course be stated here, but it seems probable that wherever the purification of the waste liquor became necessary, the recovery of these fats could be accomplished and their sale pay in part, at least, the cost of purification.

In the table given beyond the figures presented are the averages of many determinations of the fatty matters present in the tannery and wool-scouring liquors investigated.

Fats in Manufacturing Sewages.

[Parts per 100,000.]

Tannery No. 1,	97
Tannery No. 2,	26
Wool-scouring liquor,	2,000
Wool-scouring liquor after treating with calcium chloride,	88

Bacteriology of Manufacturing Sewages and of the Effluents from Filters Nos. 71 to 76.

From Aug. 15 to Dec. 15, 1896, frequent bacteriological examinations of the manufacturing sewages and the effluents from filters Nos. 71 to 76 were made, in order to determine what species of bacteria they contained, the number of bacteria present per cubic centimeter, and to determine also whether the bacteria contained in these liquors increased or diminished in number when the sewages or effluents were allowed to stand for a few days.

Average Number of Bacteria per Cubic Centimeter contained in Sewages applied to and in the Effluents from Filters Nos. 71 to 76.

Aug. 15 to Dec. 15, 1896.

	71.	72.	73.	74.	75.	76.
Sewage applied,	39,944	39,944	4,545,000	19,080,000	7,506,000	7,037,000
Effluent,	2,245,000	4,545,000	183,000	4,099,000	26,700	1,634,000

The sewage applied to filters Nos. 71 and 72 contained arsenic, and for this reason the average number of bacteria present was small. After the removal of this arsenic by filtration, bacterial life was abundant in the effluents.

As indicated in this table some of the sewages and effluents contained several million bacteria per cubic centimeter. It would have been impossible to count the colonies formed in gelatine plates by such great numbers of organisms, therefore the samples were diluted with known volumes of sterilized water before the analyses were made. By this method of treatment some of the species, represented by only a few cells in the liquors, were probably eliminated. However, by diluting the samples, the number of cells found in a cubic centimeter was reduced, making it easier to identify the colonies belonging to each species than it would otherwise have been. Certain bacteria liquefied the gelatine, others produced well-marked colors or colonies which had characteristic forms.

By taking advantage of the effect of dilution to diminish the number of bacteria on the plate and thus separate the colonies, and by noting the characteristics just described, about thirty-five different species have been detected in the various sewages and effluents. In

order to complete these determinations, detailed series of tests or analyses have been made of the most common forms.

To show the relative numbers of colonies which each of these species formed on the plates when present in the sewage or effluent examined, a table has been prepared which gives the average per cent. which the colonies belonging to any one species was of the entire number of colonies on the plate, whenever such species occurred. (See table, page 453.)

Number of Colonies belonging to a Single Species found on a Plate compared with the Whole Number of Colonies on the Plate (Percentage).

	Number of Species—																	
	61.	62.	63.	64.	65.	66.	67.	68.	69.	70.	71.	72.	73.	74.	75.	76.	77.	78.
Sewage for No. 71, .	85.0	–	0.1	96.0	1.0	99.0	5.0	–	–	–	–	–	–	–	–	0.7	0.1	–
Effluent of No. 71, .	–	–	5.0	1.0	1.0	71.0	–	5.0	1.0	–	–	17.0	–	5.0	–	23.0	–	–
Effluent of No. 72, .	–	0.1	21.0	4.0	0.7	89.0	39.0	2.0	–	–	–	–	1.0	–	–	1.0	0.6	–
Effluent of No. 73, .	–	1.0	0.2	16.0	0.5	74.0	0.8	18.0	–	–	–	10.0	18.0	0.5	–	1.0	–	1.0
Sewage for No 74, .	–	–	–	43.0	24.0	83.0	–	–	–	–	–	–	–	–	–	–	–	–
Effluent of No 74, .	0.2	–	–	0.2	0.4	53.0	–	0.3	–	0.2	3.0	–	0.9	–	–	–	–	–
Sewage for No 76, .	–	0.7	1.0	1.0	1.0	66.0	0.8	1.0	23.0	–	–	–	–	3.0	0.4	–	–	2.0
Effluent of No. 76, .	–	–	1.0	23.0	0.8	90.0	0.2	2.0	1.0	–	–	–	–	–	–	0.5	–	2.0
Sewage for No. 75, .	0.6	0.5	0.5	17.0	7.0	74.0	0.5	8.0	3.0	–	–	1.0	–	0.2	0.8	–	–	2.0
Effluent of No. 75, .	–	1.0	–	17.0	7.0	74.0	–	–	4.0	–	–	–	–	3.0	1.0	–	–	6.0

	Number of Species—																			
	80.	81.	82.	83.	84.	85.	86.	87.	88.	89.	90.	91.	92.	93.	94.	96.	97.	98.	*	†
Sewage for No. 71, .	85.0	8.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11	–
Effluent of No. 71, .	64.0	59.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.0	4.0	18	8
Effluent of No. 72, .	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10	8
Effluent of No. 73, .	–	0.4	–	–	3.0	–	–	–	–	–	–	–	–	–	–	–	–	–	14	9
Sewage for No 74, .	14.0	–	–	0.2	–	–	–	–	–	–	–	–	–	–	21.0	–	–	–	6	–
Effluent of No 74, .	84.0	–	–	–	–	–	–	–	–	–	–	–	–	–	69.0	–	–	–	10	5
Sewage for No 76, .	84.0	0.7	–	3.0	–	2.5	2.5	1.0	3.0	0.2	0.7	0.1	1.0	–	1.0	–	–	–	28	–
Effluent of No. 76, .	53.0	0.4	–	2.0	–	–	–	–	3.0	–	0.9	–	–	–	3.0	–	–	–	15	14
Sewage for No. 75, .	77.0	2.0	–	0.6	–	–	–	–	–	–	–	–	–	0.4	–	–	–	–	17	–
Effluent of No. 75, .	92.0	2.0	4.0	–	–	–	–	–	–	3.0	5.0	–	–	–	–	0.1	–	–	14	19

* Whole number of species found.

† Number of species found in the sewage applied which appeared in the effluent.

This table shows that eleven species were found in the sewage applied to filters Nos. 71 and 72, eight of which were detected in the effluents of filters Nos. 71, 72 and 73; of the six species found in the sewage applied to Filter No. 74, five were detected in its effluent; of the twenty-three species in the sewage applied to Filter No. 76, fourteen appeared in the effluent, and of the seventeen species found in the sewage applied to Filter No. 75, ten were found in the effluent. Furthermore, species numbered 63, 64, 65, 66, 67, 68, 80 and 81 were found in all the applied sewages and effluents, except in the sewage and effluent of Filter No. 74. This filter was flooded with liquor obtained by treating wool-scouring sewage with calcium chloride, straining out the precipitated sludge and neutralizing the filtrate with sulphuric acid, and when applied to Filter No. 74, as indicated in the table on page 446, contained on an average 19,000,000 bacteria per cubic centimeter, but as a result of the treatment, only six species. Of these, No. 94 deserves special mention from the fact that it occasionally appeared as almost the only species in the liquor and because it possessed the power to reduce nitrate (in bouillon) to nitrite in a marked degree.

Of the other eight species which were common to all the sewages and effluents, attention is called to Nos. 66 and 80. During the months of August and September the Bacillus No. 66 formed from 53 to 90 per cent. of the colonies found on the plates. In October great numbers of small white colonies, formed by Bacillus No. 80, appeared in the sewages and effluents. This organism differed from the preceding in that it developed rather slowly in nutrient gelatine and possessed the power to reduce nitrate (in bouillon) to nitrite with great rapidity. Of the other species, No. 63 liquefied the gelatine, forming brown colonies resembling burnt umber in color, and seemed to resemble the Bacillus ruber described by Eisenberg. Species 64 produced orange colonies and reduced nitrate (in bouillon) to nitrite rapidly. No. 65 liquefied the gelatine, reduced nitrate (in bouillon) to nitrite and was accompanied by a characteristic odor. Species 67, 68 and 81 liquefied the gelatine but possessed no other characteristics of special interest.

It will be seen that the doses for filters Nos. 75 and 76 contained many more species than the other sewages. This was undoubtedly due to the fact that the sewages applied to filters Nos. 75 and 76 were mixtures of regular Lawrence sewage and factory sewage.

The species present resembled the species in regular sewage closely, and the bacteria per cubic centimeter averaged about the same in number.

In this connection it should be noted that the pail used to measure the regular station sewage, to be mixed as described above, was sometimes used to measure the sewages to be applied to filters Nos. 71, 72, 73 and 74. The small volume of sewage left in it was sufficient probably to seed the liquors, measured later, with the bacteria which prevailed in the station sewage. This may account for the similarity of species found in these liquors.

Increase in the Number of Bacteria in Sewages which have been allowed to stand for Several Days.

The table on page 451 shows that the average number of bacteria per cubic centimeter found in the sewage applied to filters Nos. 71 and 72, during the period from August to December, averaged 39,944. In the table on page 433 the average number of bacteria is given as 1,668,743 per cubic centimeter, but this latter table includes an average of the analyses made from May to December. The apparent discrepancy shown by these two tables is due to the fact that the amount of arsenic in the sewage has varied at different seasons of the year. Sewages obtained at certain seasons (May or December, for instance) sometimes contained several million bacteria per cubic centimeter, but at other times the number found averaged less than 20,000.

When such sewage is filtered, the arsenic is removed and the bacteria increase rapidly in the purified effluent, as shown in the next table.

Comparison of the Number of Bacteria which developed in Sewage from Tannery No. 1 with the Effluents from Filters Nos. 71, 72 and 73.

[Bacteria per Cubic Centimeter in the Sample.]

	Immediately after Collection.	After Standing 24 Hours.	After Standing 48 Hours.	Arsenic (Parts per 100,000).
Tannery sewage,	2,652	438	200	2.0
Effluent from 71,	5,040,000	5,180,000	5,200,000	Less than 0.1
Effluent from 72,	5,610,000	18,860,000	28,800,000	0.1
Effluent from 73,	529,000	575,000	1,250,000	0.1

This table shows that when much arsenic was present the bacteria were few in number, but in the effluents which contained a mere trace of arsenic the bacteria increased rapidly, for a time at least.

Wool-scouring Liquors.

The sewage from wool scouring usually contained a large excess of free alkali and organic substances washed from the wool. Before applying the sewage to Filter No. 74, the liquor was treated with calcium chloride and strained, in order to remove the matters in suspension. The strained liquor, obtained in this way, was then neutralized by adding sulphuric acid, and applied to Filter No. 74, or mixed with station sewage and applied to Filter No. 76.

The bacteria in the untreated liquor included several species; in the strained liquor the number of species was smaller; in the neutralized liquor there were only a very few species; and in the neutralized liquor mixed with station sewage, to make the dose for Filter No. 74, a great many species appeared. When these liquors were allowed to stand for a few days the number of bacteria increased rapidly. This point is well illustrated in the following table: —

Number of Bacteria per Cubic Centimeter found in Wool-scouring Sewages.

	Untreated Wool-scouring Liquor.	Liquor plus Calcium Chloride strained.	Strained Liquor neutralized by adding Sulphuric Acid.	Neutralized Liquor plus Station Sewage.
Sample just collected, ...	10,000	100	200	1,942,000
Sample stood twenty-four hours, .	1,485,000	20,000	310,000	56,700,000
Sample stood three days, ...	119,600,000	10,000,000	57,000,000	71,940,000

From this table it is apparent that the number of bacteria contained in the various liquors increases most rapidly in the liquor which has been neutralized with acid. As shown elsewhere, however, the bacteria found in the neutralized liquor generally belonged to a small number of species, species No. 94 often forming nearly 90 per cent. of the colonies. The neutralized liquor was diluted to a greater degree than the other liquors, before making analyses, because this liquor was infested with moulds, and unless the samples had been diluted enough to reduce the number of moulds, the latter filled up the plates so that the bacteria could not be detected.

Sewage from Tannery No. 2.

The samples of sewage obtained at Tannery No. 2 contained, on an average, several million bacteria per cubic centimeter. The sewage applied to Filter No. 75 contained a mixture of this tannery sewage with regular station sewage.

Average Number of Bacteria per Cubic Centimeter found in the Sewage from Tannery No. 2, in the Sewage applied to Filter No. 75, and in the Effluent from Filter No. 75.

Tannery Sewage.	Sewage applied to Filter No. 75.	Effluent from Filter No. 75.
3,943,000	6,511,000	26,700

The species found in the sewage applied to Filter No. 75 and in the effluent resembled the species found in regular station sewage.

In summing up these results, it may be said that the number of bacteria found in the various sewages and effluents was very great, except in the tannery sewage, which contained arsenic; when this arsenic was removed the bacteria began to increase rapidly in numbers. The species found resembled the species found in regular sewage, and most of the species found in the sewages appeared in the effluents. A few species were found in all the sewages and effluents.

Micro-organisms found in River Water receiving the Sewage from Tannery No. 1.

Samples of water, collected from different points of the river, into which the sewage from tannery No. 1 runs, were examined for micro-organisms with the following results. This sewage, it will be remembered, contains arsenic.

Micro-organisms in Sample of Water collected at a Point in the River.

Above Tannery.	Tannery Sewage.	1,000 Feet below Tannery.	Head of Pond through which the River flows.	Near the Outlet of the Pond.
Diatoms, . . .	Diatoms, . .	Diatoms, . .	Diatoms, . .	Diatoms.
Algæ, . . .	- -	- -	- -	Algæ.
Cyanophyceæ, .	Cyanophyceæ, .	Cyanophyceæ, .	Cyanophyceæ, .	Cyanophyceæ.
Infusoria, . .	Infusoria, . .	Infusoria, . .	Infusoria, . .	Infusoria.

From this table it is apparent that after the tannery sewage enters the river the algæ disappear until the water has become partially purified by passing through the pond. Most of the cyanophyceæ and diatoms found in the river above the tannery also disappeared, but there were some micro-organisms, such as nostoc, navicula and infusoria, found even in the undiluted sewage.

The river above the tannery contained great bunches of algæ, cyanophyceæ, etc., and the stones on the bottom were coated with masses of zoöglœa, about which were clustered diatoms of many varieties and also infusoria. The algæ included spirogyra, ulothrix and other filamentous forms; cosmarium, chlorococcus and other non-filamentous forms; the cyanophyceæ included oscillaria, leptothrix, œdogonium, nostoc and other forms; the diatoms included navicula, synedra, gomphonema, tabellaria and many other forms; indeed, the diatoms were very common; the infusoria included at least three forms.

The surface of the river below the tannery, its banks and the stones which line the pond were coated with masses of a dark-green slime. On the bottom of the river and pond bunches and mats of dirty white filamentous forms had gathered, which often looked like frayed rope. These masses of slime and bunches or mats consisted of filaments of oscillaria, glœotrichia, lyngbia, protococcus forms, zoöglœa, diatoms, sludge from the tannery, infusoria, worms, etc., matted together. Most of the filamentous forms found belonged to the blue-green algæ, but associated with the latter, especially in the clusters of dirty-white rope-like bunches found on the stones, were long, cork-screw-like filaments, nearly white, which possessed marked twitching movements. They resembled beggiatoa in general appearance, but, from the presence of many similar filaments containing distinct chlorophyl bands, the white cells perhaps were filaments of oscillaria from which the chlorophyl had been bleached by the sulphur compounds set free by decomposition of the tannery sewage.

Where the stream becomes purified by sedimentation, new species of cyanophyceæ, such as oscillaria, glœotrichia, new forms of diatoms and infusoria, notably vorticella, were found. Some of these may have been introduced by the tide-water which floods the basin twice a day.

After receiving tannery sewage the character of the plant life changed; the organisms decreased in number and in species. Experiments therefore were made in order to test the effect produced

by varying volumes of tannery sewage on the micro-organisms living in the river water.

Various amounts of sewage from the settling basin at tannery No. 1 were added to flasks containing samples of water taken from the stream above the tannery. A similar series of flasks was treated with a sodium arsenite solution containing arsenic in the proportion of 980 parts, 495 parts and 248 parts per 100,000 parts of river water. As noted above, the stream contained very many species of micro-organisms.

The algæ seemed to die out after standing two or three days in waters containing the greatest amounts of sewage or arsenite, but lived for several days in the other samples. In flasks which contained small amounts of sewage or arsenite, infusoria and diatoms, especially synedra and navicula, seemed to increase; even spirogyra, etc., lived there for two weeks. As a matter of fact one species of algæ, which resembled protococcus or tetraspora, flourished for five months in a flask which contained 1 part of tannery sewage to 1 part of river water.

Effluents from filters Nos. 71, 72 and 73 produced no particular effect on micro-organisms present in pond, river and well waters, but large quantities of tannery sewage or a strong solution of arsenite destroyed such organisms as cosmarium, etc. Even in these solutions, however, certain filamentous forms and diatoms lived.

Number of Bacteria per Cubic Centimeter found in Water collected at Different Points in the River, September, 1896.

Stream above Tannery.	Tannery Sewage.	Stream 1,000 Feet below Tannery.	Head of Pond.	Near Outlet of the Pond.
785	1,984	10,858	2,520	1,162

FILTRATION OF LAWRENCE SEWAGE.

The Lawrence sewage applied to the experimental filters is drawn through a 2.5 inch pipe 4,300 feet long, from the Lawrence Street sewer at a point just below the main business street of the city and just above the entrance of wastes from the large mills. This sewer drains the streets, houses and stores of the most densely populated section of the city.

The sewage drawn from this sewer has contained more organic matter during 1896 than during any previous year in the history of the station with the exception of 1895.

Large measuring tanks receive this sewage at the station and from them it is run upon the different filters. On at least four days in each week a bottle of sewage is collected for analysis from one of these tanks, and this is known as the regular sewage.

Monthly Averages of Analyses of Regular Sewage Samples.

[Parts per 100,000.]

1896.	Temperature, Deg. F.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Total.	Soluble.	Insoluble.			
January,	49	3.71	0.78	.37	.41	8.96	4.31	3,778,000
February,	45	3.38	0.58	.33	.25	7.29	5.18	1,763,000
March,	42	4.39	0.72	.28	.44	8.29	3.80	2,510,000
April,	47	4.25	0.81	.33	.48	8.58	4.50	4,578,000
May,	59	4.47	0.75	.31	.44	10.79	3.70	4,784,000
June,	64	3.64	0.62	.28	.34	11.27	3.23	3,880,000
July,	72	3.73	0.55	.14	.41	11.00	2.71	3,142,000
August,	74	3.54	0.50	.21	.29	11.00	2.96	3,003,000
September,	65	3.78	0.57	.27	.30	10.74	3.12	3,952,000
October,	54	4.36	1.00	.33	.77	11.38	5.05	6,265,000
November,	47	5.11	1.25	.40	.85	10.93	5.46	8,742,000
December,	45	4.60	1.24	.50	.74	11.22	5.64	6,252,000
Average,	55	4.08	0.78	.31	.48	10.12	4.14	4,387,000

Analyses of samples of sewage collected each Wednesday directly from the Lawrence Street sewer, at the point where the pipe from the sewer to the station begins, have been made each week during the year. These samples have been collected in the morning when strong day sewage is flowing through the sewer. The table giving the monthly averages of the analyses of this sewage is given below, and on comparing it with the previous table it will be seen that the total nitrogen represented by the free and albuminoid ammonia is nearly the same, being 4.86 parts in the Lawrence Street sewage and 4.62 parts in the regular station sewage. The greater quantity of free ammonia and the lower quantity of oxygen consumed in the regular sewage are due to its passage through the pipe from the sewer to the station, with the consequent bacterial and chemical changes. The nitrates, nitrites and free dissolved oxygen present in the sewage when in the sewer have disappeared when the sewage reaches the station.

The second table beyond gives a monthly average of samples collected from the Lawrence Street sewer each week day during eight months of the year. The samples averaged in this table were taken

at all times of the day, both morning and afternoon, while the samples averaged in the first table beyond were all taken at about 9 o'clock in the morning.

Monthly Averages of Analyses of Sewage from the Lawrence Street Sewer.

[Parts per 100,000.]

1896.	Temperature, Deg. F.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Total.	Soluble.	Insoluble.		Nitrates.	Nitrites.		
January,	50	3.50	1.20	.68	.52	5.74	.22	.0085	7.03	2,662,000
February,	48	3.16	0.99	.65	.34	6.16	.23	.0253	5.98	2,076,000
March,	47	2.72	0.99	.68	.31	8.09	.28	.0147	6.33	3,201,000
April,	52	2.80	0.92	.59	.33	10.80	.24	.0200	5.88	4,133,000
May,	63	4.18	1.08	.69	.39	12.51	.18	.0340	6.46	6,418,000
June,	62	3.58	1.12	.68	.44	34.48	.16	.0225	5.75	5,080,000
July,	67	3.58	1.07	.64	.43	10.46	.15	.0025	6.00	4,622,000
August,	73	4.31	1.20	.70	.50	26.79	.10	.0000	5.58	6,258,000
September,	67	3.92	1.16	.72	.44	10.12	.16	.0184	6.68	6,206,000
October,	61	4.03	1.29	.76	.53	10.01	.18	.0295	7.10	5,303,000
November,	57	4.05	1.63	.91	.72	9.10	.12	.1235	6.50	7,393,000
December,	51	3.40	1.28	.82	.46	10.76	.19	.0132	7.18	4,086,000
Average,	59	3.62	1.16	.71	.45	13.34	.18	.0263	6.49	4,951,000

Monthly Averages of Analyses of Average Lawrence Street Sewage Samples.

[Parts per 100,000.]

[illegible]	Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrogen as		Oxygen Consumed.
				Nitrates.	Nitrites.	
January,	2.20	0.96	6.51	.26	.0203	6.10
February,	2.61	1.31	11.25	[illegible]	.0215	7.80
May,	2.08	0.87	11.07	.10	.0193	[illegible]
June,	2.23	0.90	[illegible]	[illegible]	.0107	6.20
July,	2.50	0.97	13.16	.11	.0115	6.78
August,	2.24	0.97	16.56	.11	.0275	6.95
September,	2.10	0.97	13.85	.15	[illegible]	6.65
October,	2.22	1.06	10.40	.18	.0192	7.20
Average,	2.27	1.00	12.88	.18	.0199	6.66

Other Samples of Sewage collected for Analysis.

In addition to the sewages represented by the preceding tables, it has been the practice to collect other representative samples for analysis, as follows: —

1. A sample representing an average of all the sewage pumped on each Tuesday of the year.
2. Samples representing weekly averages of all the sewage applied to filters Nos. 1, 6 and 9 A.
3. On each Tuesday of the year a sample of the supernatant sewage after allowing regular sewage to stand for four hours.
4. On each Tuesday of the year a sample of the supernatant sewage after treating regular sewage with sulphate of alumina in the proportion of 1,000 pounds per 1,000,000 gallons, and allowing to stand and settle for four hours.
5. On each Tuesday of the year a sample of the sewage resulting from straining regular sewage through a layer of coke breeze at a rate of 1,000,000 gallons per acre daily.

Monthly Averages of Analyses of Average Sewage Samples.

[Parts per 100,000.]

1896.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Fats.
		Total.	Soluble.	Insoluble.			
January,	4.65	0.74	.42	.32	7.36	3.93	6.26
February,	3.61	0.63	.35	.28	6.49	2.58	3.90
March,	4.12	0.60	.35	.25	6.94	3.08	3.85
April,	4.99	0.79	.40	.39	10.10	3.70	4.90
May,	4.55	1.07	.33	.74	9.26	6.45	14.85
June,	4.05	0.70	.30	.40	12.72	3.36	3.25
July,	4.43	0.68	.32	.36	13.35	3.50	7.16
August,	3.73	0.57	.21	.36	11.13	3.10	4.25
September,	4.60	0.74	.31	.43	12.11	3.87	6.36
October,	4.40	0.78	.34	.44	9.28	3.75	7.00
November,	4.75	1.21	.46	.75	9.60	4.90	7.25
December,	4.08	0.97	.40	.57	9.93	5.35	5.91
Average,	4.33	0.79	.35	.44	9.86	3.97	6.25

Monthly Averages of Mixed Samples, representing all of the Sewage applied to Filters Nos. 1, 6 and 9 A.

[Parts per 100,000.]

1896.	Free Ammonia.			Albuminoid Ammonia.			Oxygen Consumed.			Chlorine.		
	Filter No. 1.	Filter No. 6.	Filter No. 9 A.	Filter No. 1.	Filter No. 6.	Filter No. 9 A.	Filter No. 1.	Filter No. 6.	Filter No. 9 A.	Filter No. 1.	Filter No. 6.	Filter No. 9 A.
January,	4.38	4.38	4.69	0.80	0.72	0.87	4.98	4.55	4.90	7.00	7.88	7.48
February,	2.83	3.34	3.21	0.54	0.61	0.56	2.55	2.90	2.86	4.50	5.15	[illegible]
March,	3.30	4.25	3.63	0.49	0.69	0.53	2.70	3.30	3.37	5.01	5.09	5.31
April,	3.66	4.53	4.43	0.64	0.78	0.66	3.20	3.60	3.65	7.35	6.25	5.97
May,	4.57	5.24	4.01	0.71	1.06	0.56	[illegible]	4.74	3.12	7.96	11.16	8.15
June,	3.76	4.68	3.94	0.84	0.82	0.56	2.66	3.90	2.45	35.14	18.06	8.76
July,	3.79	5.03	3.36	0.64	0.80	0.43	2.35	3.75	2.65	10.24	14.42	11.08
August,	4.54	4.41	3.55	0.71	0.63	0.42	3.53	3.48	2.25	9.31	14.90	8.07
September,	4.45	4.54	3.76	0.76	0.71	0.62	3.38	3.63	2.49	9.10	11.17	9.94
October,	4.44	4.54	4.20	0.89	0.76	0.77	[illegible]	4.06	3.54	6.42	7.24	7.18
November,	4.95	5.18	5.08	1.01	1.21	1.06	4.58	5.05	5.33	6.60	6.94	7.06
December,	4.37	4.57	4.60	0.90	1.03	1.02	[illegible]	5.00	4.60	7.76	7.58	7.12
Average,	4.10	4.60	4.10	0.71	0.84	0.66	3.64	3.90	3.42	9.70	9.24	7.79

Monthly Averages of Analyses of Supernatant Liquid from Settled Sewage for Filter No. 13 A.

[Parts per 100,000.]

1896.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Fats.	Bacteria per Cubic Centimeter.
		Total.	Soluble.	Insoluble.				
January,	5.29	[illegible]	.42	.17	8.31	3.56	[illegible]	3,015,000
February,	3.53	.51	.34	.17	7.48	2.97	5.60	1,618,000
March,	4.07	.51	.30	.21	6.24	3.20	5.90	3,395,000
April,	4.95	.56	[illegible]	.16	10.11	3.09	[illegible]	[illegible]
May,	4.90	.61	.31	[illegible]	11.51	[illegible]	4.75	[illegible]
June,	3.93	[illegible]	.26	[illegible]	13.15	1.91	[illegible]	1,672,000
July,	4.27	[illegible]	.25	.06	[illegible]	2.23	2.95	2,698,000
August,	3.47	.31	.20	.11	10.42	2.30	[illegible]	2,813,000
September,	4.08	.38	.24	.14	[illegible]	2.08	[illegible]	1,828,000
October,	4.83	.59	.34	.25	[illegible]	3.33	5.66	[illegible]
November,	4.90	.75	.42	.33	[illegible]	4.30	3.35	[illegible]
December,	[illegible]	.76	.51	[illegible]	10.17	[illegible]	5.71	[illegible]
Average,	4.42	.52	[illegible]	.19	[illegible]	3.03	4.00	3,028,000

Monthly Averages of Analyses of Supernatant Liquid from Sewage treated with Sulphate of Alumina for Filter No. 19.

[Parts per 100,000.]

1896.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Fats.	Bacteria per Cubic Centimeter.
		Total.	Soluble.	Insoluble.				
January,	5.25	.47	.34	.13	8.47	2.85	3.84	540,000
February,	2.82	.26	.17	.09	5.90	1.45	0.75	187,000
March,	4.17	.28	.18	.10	6.11	1.70	3.10	345,000
April,	5.11	.37	.28	.09	9.96	1.85	2.20	1,278,000
May,	5.05	.47	.28	.19	11.18	2.55	3.80	1,664,000
June,	4.79	.32	.26	.06	11.65	1.40	1.50	992,000
July,	4.17	.28	.23	.05	10.26	1.50	2.03	1,065,000
August,	3.57	.26	.17	.09	9.80	1.68	1.50	1,607,000
September,	4.07	.30	.24	.06	10.73	1.57	2.54	1,694,000
October,	5.07	.48	.32	.16	14.92	2.20	3.00	763,000
November,	5.10	.48	.36	.12	10.12	2.40	4.05	2,185,000
December,	4.80	.54	.41	.13	9.40	3.23	2.75	1,918,000
Average,	4.50	.37	.27	.11	9.88	2.08	2.59	1,187,000

Monthly Averages of Analyses of Sewage strained through Coke for Filter No. 14 A.

[Parts per 100,000.]

1896.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Fats.	Bacteria per Cubic Centimeter.
		Total.	Soluble.	Insoluble.				
January,	5.33	.48	.31	.17	8.40	2.45	2.62	1,113,000
February,	3.02	.31	.22	.09	6.38	2.00	2.72	1,045,000
March,	4.07	.40	.22	.18	6.38	2.30	4.60	1,263,000
April,	4.86	.43	.30	.13	9.98	2.20	2.68	2,422,000
May,	4.80	.48	.28	.20	11.31	2.70	3.75	1,968,000
June,	3.26	.39	.26	.13	9.66	1.77	1.80	1,479,000
July,	3.03	.24	.19	.05	10.73	1.00	0.90	673,000
August,	2.03	.18	.14	.04	11.54	1.30	1.15	785,000
September,	3.47	.27	.22	.05	12.08	1.27	3.26	786,000
October,	4.67	.66	.34	.32	14.61	2.63	3.30	1,505,000
November,	5.35	.52	.41	.11	11.69	2.75	2.40	2,720,000
December,	4.90	.57	.42	.15	9.48	3.10	2.05	2,233,000
Average,	4.07	.41	.28	.14	10.19	2.12	2.60	1,500,000

Summarizing these results for 1896 we find that, by allowing the sewage to settle in barrels for four hours and then drawing a sample for analysis from a faucet half way between the top and bottom of the barrel, this sample shows a removal of 33 per cent. of the organic matter as represented by the total albuminoid ammonia and 27 per cent. as represented by the oxygen consumed. By the same treatment, together with the addition of sulphate of alumina, in the proportion stated, the removal has been 53 per cent. and 51 per cent. respectively. By straining through coke the removal has been 47 and 49 per cent. respectively.

These continuous experiments upon the removal of organic matter by sedimentation, chemical precipitation and straining through coke have been continued for several years, and the results obtained each year are presented in the following table: —

[Parts per 100,000.]

	1892.		1893.		1894.				1895.				1896.			
	Regular Sewage	Settled Sewage	Regular Sewage.	Chemically Precipitated.	Regular Sewage.	Settled Sewage.	Chemically Precipitated	Strained through Coke.	Regular Sewage	Settled Sewage.	Chemically Precipitated.	Strained through Coke.	Regular Sewage.	Settled Sewage.	Chemically Precipitated	Strained through Coke.
Free ammonia,	2.45	2.38	2.68	2.54	3.43	3.41	3.44	3.41	4.05	4.47	4.29	4.62	4.08	4.42	4.50	4.07
Albuminoid ammonia,	0.75	0.50	0.63	0.30	0.63	0.44	0.26	0.30	1.00	0.52	0.37	0.46	0.78	0.52	0.37	0.41
Oxygen consumed,	4.22	3.07	3.45	1.88	3.54	2.81	1.76	2.03	5.10	3.40	2.39	2.80	4.14	3.03	2.03	2.12
Fats,*	5.60	2.40	2.70	1.20	4.40	1.70	0.90	–	4.40	3.30	1.90	3.30	6.25	4.00	2.59	2.60

* In some cases the fats given under "regular sewage" are of the average sewage.

The sewages resulting from settling, precipitating and straining the regular sewage have been applied to filters Nos. 13 A, 14 A and 19, respectively, as will be described beyond. The percentage of organic matter removed by these different methods varies from year to year and depends largely upon the percentage of insoluble organic matter in the sewage treated. Thus, in 1892, 55 per cent. of the total albuminoid ammonia was insoluble and sedimentation removed 33 per cent.; in 1893, 51 per cent. was insoluble and chemical precipitation removed 48 per cent.; in 1894, 59 per cent. was insoluble and sedimentation, chemical precipitation and coke straining removed 30 per cent., 59 per cent. and 43 per cent. respectively; in 1895, 72 per cent. was insoluble and the removal by these three processes was 48, 63 and 61 per cent. respectively; while in 1896, with 62 per

cent. of the total albuminoid ammonia insoluble, the per cent. of removal by the three processes has been 33, 51 and 47 respectively.

COMPARISON OF THE STRENGTH OF STATION SEWAGE.

Bringing together for comparison the average results of the analyses of the several series of samples of untreated sewage gives us the following table: —

Average Analysis.

[Parts per 100,000.]

1896.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Total Nitrogen.
		Total.	Soluble.	Insoluble.			
Regular,	4.08	.78	.31	.48	10.12	4.14	4.63
Average,	4.33	.79	.35	.44	9.86	3.97	4.86
For Filter No. 1,	4.10	.71	.28*	.43	9.70	3.64	4.52
For Filter No 6,	4.60	.84	.34*	.50	9.24	3.99	5.15
For Filter No. 9 A,	4.10	.66	.26*	.40	7.79	3.42	4.44

* Estimated.

COMPOSITION OF SEWAGE.

The percentage of the nitrogen in a sewage, determined by the albuminoid ammonia process, varies with the age of a sewage, that is, with its freshness or staleness. Figures in regard to this fact have been given in the last two reports, and the subject has been further studied during 1896, not only with fresh and stale city sewage but also with the various manufacturing sewages examined.

A continuous comparative determination, by both the albuminoid ammonia and Kjeldahl processes, of the organic nitrogen present in the stale sewage pumped at the station and the fresh Lawrence Street sewage has been made. This examination continued for five months, June to October inclusive, and the results are presented in the following table: —

Comparison of Nitrogen determined as Albuminoid Ammonia (Wanklyn) with Organic Nitrogen (Kjeldahl).

[Parts per 100,000.]

	Station Sewage.	Lawrence Street Sewage.
Nitrogen as albuminoid ammonia,	0.44	0.94
Organic nitrogen,	1.02	2.56
Per cent. which former is of latter,	43	37
Average per cent, 1894-95,	39	26

The figures given in the previous years have shown a smaller percentage of nitrogen determined by the albuminoid ammonia process. These former figures have been calculated from analyses of series of samples taken each hour for twenty-four hours and cover a period of one day only, but include, of course, all the various kinds of sewage, weak and strong, flowing in the sewer during that day. On the other hand, the 1896 figures cover a five months' period, but are of samples of morning sewage only, and it has been found that this strong sewage yields a larger percentage of its organic nitrogen as albuminoid ammonia than does the weaker night sewage. A larger percentage of the organic matter present was in solution in 1896 than during previous years, and this fact probably had considerable influence upon the percentage determined by the albuminoid ammonia process.

Manufacturing Sewages.

Bringing together the comparative determinations made by both the Wanklyn and Kjeldahl processes of the nitrogen in the manufacturing sewages gives us the following table: —

Comparison of Nitrogen determined as Albuminoid Ammonia (Wanklyn) with Organic Nitrogen (Kjeldahl).

[Parts per 100,000.]

	Entire Sewage of Tannery No. 1.	Supernatant Sewage of Tannery No. 1.	Entire Sewage of Tannery No. 2	Supernatant Sewage of Tannery No. 2.	Wool-scouring Liquor (clarified).
Nitrogen as albuminoid ammonia, . .	5.09	2.20	2.71	1.85	9.38
Organic nitrogen (Kjeldahl), . . .	14.17	5.71	5.92	4.54	21.90
Per cent. which former is of latter, .	36	39	46	41	43

The analyses of the tannery sewages were made as soon as the samples were received at the laboratory, but this was generally twenty-four hours after their collection, although occasionally they were received upon the day of collection. This fact gave a lengthened period for decomposition and the consequent breaking up of organic matter into bodies more easily oxidized by the permanganate used in the Wanklyn process, but had little influence upon these particular results, for tannery sewage is of considerable age and in an advanced state of decomposition when allowed to run to waste from the tannery. Besides this the samples of sewage from tannery No. 1 almost invariably contained enough arsenic to stop further decomposition.

Disposal of Fresh and Stale Sewage.

In regard to the changes in the organic constituents of sewage that take place as the sewage grows older, it can be said that considerable data have been given in the last two reports. It has become evident, and has been so stated in part, that when sewage is fresh, that is to say, when the mixture of water and decomposable matter of all kinds such as is found in sewage has just occurred, these matters can be strained or precipitated out quite readily from the main body of the liquid. This is the reason why it has been stated by many that sewage should reach its disposal area as soon as possible, that is, in as fresh a condition as possible, in order that this separation may be accomplished with the best results. The separated sludge then remains to be cared for either by disposal upon separate sludge beds or mixed with earth and a compost formed. The disposal upon sludge beds often means simply that it is allowed to run upon these beds and by draining become separated from the large percentage of water contained in it, after which it is scraped from the bed and composted. If the entire sewage is allowed to run upon the main beds the crude, insoluble organic matters are strained out upon the surface of the beds, and, accumulating, need to be disturbed frequently or scraped from the surface. If, on the other hand, the sewage is stale and has undergone comparatively long-continued mechanical, chemical and bacterial actions, not only is the crude organic matter more finely divided and hence more readily enters the interstices of the filtering material as stated in the last report of the Board, but the sewage has actually lost crude organic matter both by the change of organic nitrogen into free ammonia and also by the reduction of the organic matters, measured by the oxygen consumed, on account of the formation and liberation of gaseous compounds of carbon. For example, the table given on page 461 of the report of the Board for 1894 shows that when a bottle of fresh sewage was allowed to stand for twenty-four hours the organic nitrogen (Kjeldahl) decreased 51 per cent. and the oxygen consumed 25 per cent., while the free ammonia increased over 100 per cent.

To illustrate the difference in the disposal of fresh and stale sewage two small tube filters containing equal depths of the same grade of sand were put in operation in May. To one of these filters sewage taken directly from the city sewer and brought immediately to the station has been applied, while the other has received the sewage pumped at the station.

The average monthly analyses of the two sewages is given in the following table: —

[Parts per 100,000.]

	Month.	Free Ammonia.	Organic Nitrogen (Kjeldahl).	Total Nitrogen.	Oxygen Consumed.
Stale sewage,	May,	4.01	1.12	4.52	3.12
Fresh sewage,	May,	2.08	2.30	3.78	6.20
Stale sewage,	June,	3.94	0.93	4.16	2.45
Fresh sewage,	June,	2.23	2.53	4.46	6.20
Stale sewage,	July,	3.86	0.86	4.02	2.65
Fresh sewage,	July,	2.50	2.49	4.54	6.73
Stale sewage,	August,	3.55	0.73	3.44	2.25
Fresh sewage,	August,	2.24	2.36	4.20	6.95
Stale sewage,	September,	3.76	1.02	4.10	2.48
Fresh sewage,	September,	2.10	2.49	4.21	6.65
Stale sewage,	October,	4.20	1.55	4.99	3.84
Fresh sewage,	October,	2.20	2.93	4.75	7.20
Average of stale sewage,		3.39	1.04	4.23	2.80
Average of fresh sewage,		2.23	2.52	4.35	6.66

The following tables give the monthly analyses of the effluents of these two filters. Filter F received the stale and Filter H the fresh sewage.

Effluent of Filter F.

[Parts per 100,000.]

Month.	Ammonia.		Nitrates.	Nitrites.	Total Nitrogen.
	Free.	Albuminoid.			
May,	.7137	.0615	1.0500	.0620	1.7980
June,	.1067	.0338	1.4444	.0165	1.6030
July,	.0360	.0204	1.5710	.0015	1.6355
August,	.0130	.0176	1.9250	.0009	1.9654
September,	.0090	.0220	1.9900	.0008	2.0342
October,	.0108	.0285	1.6410	.0007	1.6973
Average,	.1482	.0305	1.6036	.0137	1.7889

Effluent of Filter H.

[Parts per 100,000.]

Month.	Ammonia.		Nitrates.	Nitrites.	Total Nitrogen.
	Free.	Albuminoid.			
May,	.2160	.0344	0.8710	.0090	1.1035
June,	.0297	.0275	1.4040	.0074	1.4808
July,	.0145	.0205	1.4140	.0007	1.4601
August,	.0104	.0272	1.3266	.0003	1.3700
September,	.0105	.0250	1.7272	.0002	1.7770
October,	.0284	.0288	1.3720	.0013	1.4438
Average,	.0516	.0272	1.3358	.0031	1.4392

Comparing these tables of sewages and effluents it will be seen that the total nitrogen applied to these filters was nearly equal in both cases, but that 42 per cent. of the nitrogen applied to Filter F was found in the effluent of that filter, while the effluent of Filter H contained only 33 per cent. of the nitrogen applied. These figures are of the nitrogen in the forms given in the table, but the fresh sewage applied to Filter H invariably contained nitrogen as nitrates; these nitrates averaged .15 part per 100,000, and this added to the average total nitrogen given makes this average 4.50 parts per 100,000, and the percentage of nitrogen found in the effluent 32.

An examination of the sand of each filter at the close of the experiment showed that the sand of Filter F, which received the stale sewage, contained about 12 per cent. of the applied nitrogen, and the sand of Filter H, which received the fresh sewage, contained 26 per cent. of the applied nitrogen.

The upper 3 inches of sand in Filter F contained 38 parts per 100,000 by weight of nitrogen, and the similar sand of Filter H, 78 parts per 100,000.

These two filters were both operated at a high rate, considering the strength of the sewage applied, but Filter F, receiving a sewage having 75 per cent. of its nitrogen in the form of free ammonia, disposed of it more readily than Filter H, receiving sewage containing 42 per cent. of its nitrogen in the form of free ammonia.

Permanency of Sewage Filters.

There are now in operation at the station six filters, $\frac{1}{200}$ of an acre in area and containing different grades of filtering material, which have been in operation for periods varying from five to nine years. The actual number of gallons of sewage applied to these filters from their date of construction up to Jan. 1, 1897, is given in the following table:—

Filter Number.	Date when Sewage was First Applied.	Actual Number of Gallons Applied.	Gallons per Acre.
1,	Jan. 10, 1888,	1,166,345	233,269,000
2,	Dec. 19, 1887,	557,268	111,453,600
4,	Dec. 19, 1887,	392,685	78,537,000
5 A,	Sept. 14, 1891,	693,770	138,754,000
6,	Jan. 12, 1888,	753,249	150,649,800
9 A,	Nov. 18, 1890,	762,082	152,416,400

Filters Nos. 1, 6 and 9 A contain material with an effective size of 0.48, 0.35 and 0.17 millimeter respectively, and with these three filters the entire depth of material above their underdrains is of one kind. The material in filters Nos. 1 and 9 A is very uniform, while the material in Filter No. 6 varies from gravel to sand. These three filters on Jan. 1, 1892, after four years' operation of Nos. 1 and 6 and one year of No. 9 A, had had applied to them and had stored the following amounts of nitrogen: —

Nitrogen in Pounds.

	Applied.	Stored.
Filter No. 1,	104.5	16.0
Filter No. 6,	66.0	11.8
Filter No. 9 A,	38.5	8.4

On Jan. 1, 1897, these three filters, after nine years' operation of Nos. 1 and 6 and five years' operation of No. 9 A, had had applied to them and contained the following amounts of nitrogen: —

Nitrogen in Pounds.

	Applied.	Stored.
Filter No. 1, ...	333.0	17.0
Filter No. 6, ...	250.0	22.0
Filter No. 9 A, ...	249.0	17.0

Between January, 1892, and January, 1897, 9 inches of sand were removed from the surface of Filter No. 1, 5 inches in June, 1892, containing 8.73 pounds of nitrogen, and 4 inches in May, 1893, containing 10.50 pounds. The amount of nitrogen stored in this filter between January, 1892, and May, 1893, increased so rapidly that after this removal of 19.23 pounds, 3 pounds more than the entire amount of nitrogen stored in the filter upon Jan. 1, 1892, the filter still contained 10 pounds of nitrogen. At the end of 1896, however, three and one-half years after this last removal of clogged sand, no more nitrogen was stored in the lower 54 inches of sand of the filter than in May, 1893, and the upper 9 inches of the filter, the new material added in May, 1893, contained a little less nitrogen than it did one year after being placed in the filter.

Filter No. 6 stored nitrogen quite steadily, and in May, 1892, 2 inches of sand containing 2.7 pounds, and in September, 1893, 2 inches containing about 3.8 pounds of nitrogen were removed from the surface of the filter. Four inches of clean sand were added to the filter to take the place of that removed, but within a year the stored nitrogen had increased to about the amount now present in the filter.

Filter No. 9 A, during a portion of 1892 and 1893, was used for experimental purposes to show the effect of repeated scraping of the surface when clogged instead of the weekly raking given the other filters. On March 14, 1893, it was filled to its original depth, and during the past two years the amount of stored nitrogen present has varied but not increased, an examination at the end of 1896, showing the same amount as in March, 1895.

Since 1893 there has been no removal of filtering material from any of these large experimental filters, and the removal or destruction of the large amount of organic matters of the sewage has been accomplished without impairing the action or shortening the life of the filter. That is to say, this organic matter has either passed from

the filters into the air in gaseous forms of carbon and nitrogen or has united with a base and passed away in the effluent in the form of mineral salts in solution.

EXPERIMENTS UPON STORAGE AND LOSS OF NITROGEN.

It was found in the beginning of these investigations that a varying proportion of the nitrogen applied to the filters was not stored in the filtering materials, neither did it pass away in the effluent. Quite a large number of examinations of filtering materials, which had been in use in the filters, for the determination of the nitrogen present, together with determinations of the nitrogen applied, and coming away in the effluent, indicated that 30 per cent. of the applied nitrogen was unaccounted for. Therefore 30 per cent. of the nitrogen was considered to have passed into the air in gaseous forms.

Tables were given in the reports of 1893 and 1894 to show the storage or loss of nitrogen by the different filters, and in making the calculations for the figures presented in the tables this 30 per cent. factor was used; that is to say, to the total nitrogen found in the effluent of each filter 30 per cent. was added and this sum compared with the total nitrogen in the applied sewage. These tables were of value and gave an approximation of the actual storage or loss of nitrogen. As this 30 per cent. factor, however, was determined by examining small samples of sand taken from the large amount in the filters, further investigations in regard to storage and loss of nitrogen have been made. Another reason for investigation was the fact that these tables showed a great storage of nitrogen in some of the filters of fine material which continued in efficient service.

For this experiment three small tube filters were started, each filled with sand of a different effective size, the total amount of sand used in each filter being so small that it could all be mixed in a pail and representative samples obtained. These filters were operated for six months and nitrification was active in each of them. An average sample of all sewage applied was collected and analyzed, the organic nitrogen being determined by the Kjeldahl process; the entire effluent of each filter was collected and analyzed, and at the end of the experiment the entire body of sand in each filter was examined for nitrogen present.

These three filters were known as E, F and G. E was of sand of an effective size of 0.04 millimeter, F of sand of an effective size

of 0.17 millimeter, and G of sand of an effective size of 0.48 millimeter. Filter E received sewage at the rate of 25,000 gallons per acre daily and filters F and G at the rate of 50,000 gallons per acre daily.

The average total nitrogen in the sewage used is shown by the following table. The total nitrogen is the organic nitrogen, determined by the Kjeldahl process, plus the nitrogen of the free ammonia.

Average Total Nitrogen in Sewage applied to Filters E, F and G.

[Parts per 100,000.]

May,	4.41
June,	4.26
July,	4.03
August,	3.64
September,	4.10
October,	5.00

The following tables show the monthly averages of the analyses of the effluents of filters E, F and G: —

Monthly Averages of Analyses of Effluent of Filter E.

[Parts per 100,000.]

Date — 1896.	Ammonia.		Nitrogen as		Total Nitrogen.
	Free.	Albuminoid.	Nitrates.	Nitrites.	
May,	1.1700	.1566	1.5119	.0127	2.75
June,	1.0111	.1013	0.1321	.0054	1.05
July,	0.0411	.0351	0.1846	.0034	0.28
August,	0.2680	.0644	0.3998	.0029	0.73
September,	0.3700	.0725	1.1703	.0027	1.59
October,	0.2128	.0444	1.4770	.0012	1.72
Average,	0.5122	.0791	0.8126	.0047	1.37

Monthly Averages of Analyses of Effluent of Filter F.

[Parts per 100,000.]

Date — 1896.	Ammonia.		Nitrogen as		Total Nitrogen.
	Free.	Albuminoid.	Nitrates.	Nitrites.	
May,	.7138	.0615	1.0460	.0620	1.79
June,	.1067	.0333	1.4478	.0165	1.61
July,	.0384	.0204	1.5710	.0015	1.64
August,	.0108	.0176	1.7246	.0009	1.76
September,	.0090	.0220	1.9895	.0008	2.03
October,	.0108	.0284	1.6410	.0007	1.78
Average,	.1483	.0305	1.5700	.0137	1.93

Monthly Averages of Analyses of Effluent of Filter G.

[Parts per 100,000.]

Date — 1896.	Ammonia.		Nitrogen as		Total Nitrogen.
	Free.	Albuminoid.	Nitrates.	Nitrites.	
May,	1.1725	.2800	1.5177	.1871	3.12
June,	0.0193	.0822	1.5850	.0026	1.74
July,	0.0158	.0478	1.5976	.0017	1.69
August,	0.0132	.0384	1.3634	.0021	1.43
September,	0.0145	.0405	1.6180	.0015	1.70
October,	0.0096	.0368	1.6140	.0009	1.68
Average,	0.2075	.0876	1.5493	.0327	1.89

Of the nitrogen applied to E, 33 per cent. appeared in the effluent but there was no increase in the amount of nitrogen stored in the sand, thus leaving 67 per cent. of the applied nitrogen unaccounted for.

Of the nitrogen applied to F, 46 per cent. appeared in the effluent and 12 per cent. was stored in the sand, leaving 42 per cent. unaccounted for.

Of the nitrogen applied to G, 44 per cent. was found in the effluent but there was no increase in the amount of nitrogen stored in the sand, thus leaving 56 per cent. unaccounted for.

These experiments were carried on during the warmest six months of the year, and the disappearance of nitrogen was, of course, greater than would be the average for the entire year, but the results are interesting and point towards two conclusions: First, that with a filter of fine sand by which a considerable percentage of the organic matters is strained out and held near the surface, a larger proportion of nitrogen passes into the air in gaseous forms than is the case with a filter of coarse sand. Second, that of two filters of comparatively coarse sand into which the sewage penetrates easily, the one in which the air circulates most freely will store the least nitrogen.

Removal of Sludge from Sewage.

Studies of different methods of removing sludge have been continued throughout the year, as follows: —

1. Rapid filtration through coarse gravel with the aid of a current of air drawn down through the gravel.

2. Rapid filtration through coarse gravel with the aid of a current of air forced up through the gravel.
3. Sedimentation.
4. Chemical precipitation.
5. Straining through coke.

Discussion of the Several Methods.

Forced Filtration with Aeration.

The gravel filters 15 B and 16 B, receiving sewage at a very high rate in gallons per acre and aerated by means of a current of air drawn down through them, have been continued in operation. These filters were first put in operation in July, 1892, and since the first part of 1893 filtration has been aided by the air current. From the time the aspirators were attached to the filters until September, 1894, air was constantly drawn down through these filters, $\frac{1}{20,000}$ of an acre in area, at the rate of about one gallon every four minutes. On the latter date the method of aeration was changed so that the filters were aerated only at night for twelve or sixteen hours. Remarkable results have been obtained by this method of filtration and aeration, and the filters, operating at average rates of about 450,000 gallons per acre daily during 1893, 1894 and 1895, and 350,000 gallons per acre daily during 1896, have shown on different years a removal of organic matter of the applied sewage varying from 60 to 85 per cent. A large proportion of this removed organic matter has been oxidized within the filter, but enough has accumulated from time to time in the filters to render its removal necessary if the filters were to be continued in service. This removal has been accomplished, on several occasions during 1894 and 1895, by flushing the filters out with city water or removing the entire filtering material and washing it. Early in 1896 the filters again became so badly clogged by the storage of organic matter that it was necessary to remove it. Allowing the filters to rest and increasing the air supply was resorted to, but apparently this had little effect upon the organic matter, for, upon starting filtration of sewage again, nitrification could not be established. As an experiment, city water was applied at a low rate for a few days and the filters aerated. In this medium nitrification in Filter 15 B became active, and the stored organic matter was nitrified and carried away in the effluent in such an amount that the filter has since been in good condition and successful operation.

Filter 16 B, however, was so badly clogged that the filtering material had to be removed and washed.

The rate of filtration has been lower during the remainder of 1896, in order to avoid, if possible, this storage of organic matters in the filters.

Filtration through Gravel with a Current of Air forced up through the Gravel.

Experiments carried on during 1895, upon rapid filtration through gravel and coke aided by a current of air forced up through the filters by a fan blower, were described in the report for that year.

One result of this experiment was to prove that the fan blower could not force air through the clogged surfaces of the filters, as of course was necessary if the air in the main body of the filtering material was to be frequently renewed.

Early in 1896 a somewhat similar experiment was started. A filter containing 5 feet in depth of gravel of the same grade as in filters 15 B and 16 B was constructed and the air supply was forced up through the filter by means of a pressure pump. This pump is run by electric power and pumps slightly more than 18 gallons of air per minute, as determined by careful measurements. The filter has received sewage at the rate of 352,000 gallons per acre daily in ten equal doses between 7 A.M. and 5 P.M. It has been aerated between each application of sewage for fifteen minutes, making a total period of aeration of one hundred and fifty minutes daily, and the total quantity of air pumped into the filter 2,700 gallons daily, or three and one-half times the entire capacity of the filter tank when empty and about eight times the air capacity or open space of the filtering material when in position.

From the beginning of operation of the filter nitrification has been active and fully equal to that obtained in filters Nos. 15 B and 16 B, but the percentage removal of organic matter has not been equal to that obtained by these filters. This is owing to the fact that the effluents of 15 B and 16 B pass through trapped outlets and are better strained, while Filter No. 66 has very many openings or outlets for its effluent, and the organic matter, not nitrified or lost into the air, passes down through these outlets instead of being strained out and stored, as is the case in 15 B and 16 B. (For details of operation of Filter No. 66 see page 502.)

Further Purification of the Effluents of Filters 15 B, 16 B and 66.

This rapid filtration gives at best but partially purified effluents, and the rate at which these effluents can be further purified by ordinary sand filtration has been continuously studied, together with the preliminary filtration. Filter No. 12 A, containing 5 feet in depth of sand of an effective size of 0.19 millimeter, has received the combined effluents of filters Nos. 15 B and 16 B for the past five years. The highest average rate, in gallons per acre daily, obtained by this filter was in 1893, — 745,000 gallons. (See table and discussion, page 482, report of 1895.) Its rate during 1896, exclusive of the month of May, when it was resting, has been 478,000 gallons per acre daily. As these three filters, Nos. 12 A, 15 B and 16 B, are of the same area, the rate for the combined area has been 160,000 gallons per acre daily. The effluent of Filter No. 12 A has been of most excellent quality (see page 493). The effluent of Filter No. 66 has been applied to Filter No. 67, containing 5 feet in depth of sand of an effective size of 0.19 millimeter. The average rate of filtration obtained by this filter has been 608,500 gallons per acre daily. As Filter No. 66 is of twice the area of Filter No. 67, the rate for the combined area has been 203,000 gallons per acre daily. This rate has been maintained with difficulty, the surface of No. 66 needing constant attention and the removal of a large amount of clogged sand. (For details of operation see page 502.)

Sedimentation.

For several years the supernatant sewage obtained by allowing regular sewage to stand and settle for a definite period has been applied to a sand filter. This filter is known as Filter No. 13 A and in 1893 received sewage at the rate of 416,000 gallons per acre daily. This rate was reduced to 240,000 gallons per acre daily in January, 1894, and on July 1 of the same year to 160,000 gallons per acre daily, at which rate the filter has since been operated.

The sewage applied to this filter at the present time is fully as strong in units of unoxidized nitrogen as was the regular sewage during the first years of operation of the station.

The effluent of the filter has been of a satisfactory quality, but the nitrogen stored in the filtering material is increasing. (For details of operation of Filter No. 13 A see page 495.)

Chemical Precipitation.

Since January, 1893, the supernatant sewage from regular sewage which has been allowed to settle for four hours after treatment with crude alum, at the rate of 1,000 pounds per million gallons, has been applied to a sand filter. This filter contains 5 feet in depth of sand of an effective size of 0.17 millimeter. During 1893 the average rate of filtration was 267,000 gallons per acre daily, with a maximum rate of 640,000 gallons during November. This rate was reduced on Jan. 1, 1894, to 360,000 gallons per acre daily, and upon July 1 of the same year to 200,000 gallons per acre daily, at which rate the filter has since been operated.

The quality of the effluent of this filter has been almost uniformly satisfactory, but the stored nitrogen of the filter is slowly increasing. (For details of operation of Filter No. 19 during 1896 see page 497.)

Straining through Coke.

Since June 1, 1894, sewage which has passed through a thin layer of coke breeze has been applied to a sand filter containing 5 feet in depth of sand of an effective size of 0.19 millimeter. During 1894 the rate of application was 345,000, during 1895 307,000, and during 1896 280,000, gallons per acre daily.

The effluent of the filter has been of a satisfactory quality, but the nitrogen stored in the filter is gradually increasing. (For details of operation of Filter No. 14 A during 1896 see page 496.)

Conclusions.

The chief benefit derived from the method of rapid filtration and aeration is the destruction of a considerable percentage of the crude organic matter or sludge contained in the sewage. By sedimentation or chemical precipitation we only concentrate this sludge in a small volume of the sewage. It is true, however, that we do not by the amount of aeration given our coarse filters destroy all the crude organic matter of the sewage, as some comes away in the effluent and some remains stored in the filters. With more aeration a larger proportion of this organic matter would be oxidized, but not an amount proportional to the increased aeration. The results obtained here and elsewhere with this method have been remarkable, but its practical operation depends upon obtaining the high efficiency of the coarse filters at a reasonably low cost for the power used to

supply the air current, and our experiments have tended to show that this cost is prohibitive. Our best results with this method gave a quantitative efficiency of 248,000 gallons per acre daily as calculated upon the total area of gravel and sand filters. (See page 482, report of 1895.) This was with newly constructed filters and a sewage not as strong as that which is now pumped at the station. This rate is no greater than that at which newly constructed filters, receiving the supernatant sewage from sedimentation or chemical precipitation, can be operated, and it is reasonably certain that the sludge resulting from these methods can be taken care of more cheaply than it can be oxidized or burnt up in the aerated gravel filters. When coke breeze can be obtained and the sewage given a preliminary treatment before sand filtration by being passed through this breeze at a high rate in gallons per acre daily, the organic matters of the sewage can be removed from the entire body of the sewage as completely as chemical precipitation removes them from the main body of the sewage. There is no resulting sludge liquor from this coke-straining process, and the clogged coke can be removed from time to time and burned, the sludge being, of course, held by it and burned with it.

Yearly Averages.

The eight following tables present the average analyses of "regular" sewage for each year of operation of the station, together with the average yearly analysis of the effluent of each of the large filters $\frac{1}{200}$ of an acre in area, during their entire period of operation up to Jan. 1, 1897.

Comparison by Years of the Composition of "Regular" Sewage obtained at the Experiment Station, with the Average Quantities pumped and the Local Annual Rainfall.

[Parts per 100,000.]

Year.	Average Quantity of Sewage Filtered — Gallons per Day	Annual Rainfall. — Inches.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. [illegible]	Albuminoid Ammonia. Insoluble.	Chlorine.	Oxygen Consumed.	Total Nitrogen.	Bacteria per Cubic Centimeter.
1888,	2,230	55.11	1.55	0.69	[illegible]	.58	6.19	–	2.40	1,000,000
1889,	3,410	47.64	1.84	0.55	.29	.26	4.92	–	2.41	708,000
1890,	3,300	51.73	1.82	0.69	.38	.31	5.45	3.26	2.62	1,085,000
1891,	2,730	40.00	2.22	0.73	.34	.39	7.87	3.64	3.02	693,000
1892,	2,590	34.98	2.45	0.75	.34	.41	8.33	4.22	3.24	809,000
1893,	2,850	41.96	2.69	0.63	.31	.32	8.57	3.46	3.29	924,000
1894,	2,000	32.35	3.43	0.63	.26	.37	8.07	3.54	3.56	1,329,900
1895,	2,280	39.05	4.05	1.00	.28	.72	11.43	5.10	4.96	2,907,000
1896,	2,000	38.64	4.08	0.78	.31	.47	10.12	4.14	4.62	4,387,000
Averages,	2,600	42.38	2.68	0.72	.30	.42	7.72	3.91	3.37	[illegible]

Yearly Averages of Analyses of Effluent of Filter No. 1.

[Parts per 100,000.]

Year.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.	Ammonia		Chlorine.	Nitrogen as		Total Nitrogen.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Free.	Albuminoid.		Nitrates.	Nitrites.			
1888,	53,400	52	.1823	.0277	4.97	[redacted]	.0031	1.00	–	14,814
1889,	63,600	54	.0639	.0288	4.64	1.4960	.0017	1.60	–	1,878
1890,	84,200	53	.1362	.0392	5.92	1.3572	.0039	1.53	[redacted]	15,877
1891,	115,800	52	.2367	.0490	7.57	[redacted]	.0222	1.80	.39	20,000
1892,	124,100	54	.3092	.0757	8.52	1.5287	.0212	1.92	.54	55,992
1893,	105,900	53	.5682	.0965	7.21	2.1269	.0288	2.76	.65	99,268
1894,	70,800	55	.4719	.0674	9.33	3.1200	.0606	3.68	.45	73,800
1895,	67,400	55	.6889	.0647	11.74	2.6792	.1000	3.65	.69	65,900
1896,	56,800	55	.3646	.0543	9.35	2.9600	.0618	3.43	.48	30,300
Average,	82,400	54	.3580	.0581	7.67	1.9317	.0332	2.36	.49	41,880

Yearly Averages of Analyses of Effluent of Filter No. 2.

[Parts per 100,000.]

Year.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.	Ammonia		Chlorine.	Nitrogen as		Total Nitrogen.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Free.	Albuminoid.		Nitrates.	Nitrites.			
1888,	28,200	51	.1825	.0129	4.85	0 6630	.0168	0.85	–	1,346
1889,	32,000	53	.0063	[redacted]	4.91	1.1010	.0045	1.13	–	49
1890,	59,600	53	.0083	.0102	5.44	1.6250	.0003	1.65	.09	102
1891,	50,800	53	.3141	.0258	7 59	1.0481	.0083	1.35	.22	93
1892,	24,500	53	.5768	.0283	8.03	1.4445	.0070	1.97	.23	32
1893,	40,300	51	.2815	.0233	7.03	2.4070	.0569	2.73	.19	2,116
1894,	43,900	53	.1039	.0173	7.92	2.3500	.0138	2.95	.15	630
1895,	33,700	52	.5753	.0263	10.36	2.6700	.0082	3.19	.25	546
1896,	37,000	54	.3360	.0267	9.81	3.2800	.0027	3.60	.21	49
Average,	38,900	53	.2649	.0200	7.33	1.8985	.0132	2.16	.19	551

Yearly Averages of Analyses of Effluent of Filter No. 4.

[Parts per 100,000.]

Year.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. — Deg. F.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Total Nitrogen.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
1888, ...	28,700	51	.3102	.0346	4.62	0.2200	[illegible]	0.53	–	303
1889, ...	20,000	53	.0104	.0122	[illegible]	0.6420	[illegible]	0.67	–	36
1890, ...	33,200	52	.0018	.0125	6.00	1.2860	.0000	1.25	.14	294
1891, ...	41,400	52	.0581	.0153	5.62	1.4475	[illegible]	1.52	.17	50
1892, ...	41,800	53	.5236	.0542	6.95	0.6807	.0027	1.30	.79	94
1893, ...	32,300	52	.0891	.0313	6.61	1.4536	.0034	1.28	.35	43
1894, ...	20,100	54	.4786	.0330	7.85	1.5242	.0061	1.98	.42	119
1895, ...	16,800	56	.0363	.0190	9.41	2.0600	.0020	2.12	[illegible]	319
1896, ...	19,000	54	.2201	.0281	10.31	2.7800	.0042	3.02	.19	71
Average, . . .	28,000	53	.1928	.0267	6.85	1.3416	.0024	1.54	.32	203

Yearly Averages of Analyses of Effluent of Filter No 5 A.

[Parts per 100,000.]

Year.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week	Temperature. — Deg. F	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Total Nitrogen.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
1891, ...	64,000	53	.3316	.0418	7.48	0.8700	.0116	1.22	.32	99,000
1892, ...	94,400	54	.3150	.0930	8.65	1.1384	.0276	1.99	.69	99,090
1893, ...	119,200	53	.5843	.1266	7.57	1.8203	.0133	2.52	.72	214,102
1894, ...	90,600	54	.6474	.0878	9.11	2.6700	.0382	3.38	.56	106,700
1895, ...	68,300	55	.9945	.1151	11.33	2.4700	.0214	3.50	.75	152,800
1896, ...	56,100	55	.9907	.1424	12.76	3.0300	.0700	4.14	.86	150,600
Average, . . .	82,100	54	.7256	.1011	9.45	1.9998	.0304	2.79	.65	136,347

Yearly Averages of Analyses of Effluent of Filter No. 6.

[Parts per 100,000.]

Year.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week	Temperature. Deg. F.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Total Nitrogen.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
1888, . . .	39,500	52	.0905	.0180	4.71	0.7050	.0020	0.80	–	2,083
1889, . . .	41,000	53	.0063	.0095	4.80	1.4204	.0004	1.44	–	520
1890, . . .	55,200	52	.0096	.0179	5.45	1.2349	.0005	1.27	.10	7,969
1891, . . .	61,200	52	.1725	.0302	7.30	1.3363	.0027	1.53	.26	6,473
1892, . . .	45,900	54	.7055	.0437	6.42	1.6170	.0320	2.28	.40	6,911
1893, . . .	85,500	53	.4820	.0610	7.39	2.1896	.0996	2.78	.42	11,790
1894, . . .	54,300	55	.1760	.0473	9.80	2.9800	.0962	[illegible]	.43	10,730
1895, . . .	57,600	53	.7271	.0698	10.96	2.5400	.0797	3.35	.54	20,884
1896, . . .	56,800	55	.6067	.0652	10.49	2.7300	.1266	3.46	.58	21,200
Average, . .	55,300	53	.3309	.0397	7.68	1.8615	.0490	2.13	.39	9,946

Yearly Averages of Analyses of Effluent of Filter No. 9 A.

[Parts per 100,000.]

Year.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Total Nitrogen.	Oxygen Consumed	Bacteria per Cubic Centimeter.
1890, . . .	110,000	–	.8275	.0450	5.37	0.0711	.0057	0.83	.16	4,685
1891, . . .	95,600	52	.5094	.0240	6.26	1.3272	.0098	1.79	.22	676
1892, . . .	68,100	54	.6470	[illegible]	[illegible]	1.3206	.0123	1.93	.35	2,401
1893, . . .	111,700	53	.7244	.0598	7.52	1.9551	.0047	2.65	.40	13,357
1894, . . .	68,800	54	.5252	.0432	8.14	2.9000	.0079	3.41	[illegible]	14,030
1895, . . .	66,000	54	.9863	.0734	9.84	2.5300	.0305	[illegible]	[illegible]	31,434
1896, . . .	56,300	54	.6431	.0608	8.99	3.7900	.0364	3.85	.47	17,700
Average, . .	82,400	54	.6947	.0492	8.08	1.8902	.0150	2.56	.35	12,042

Yearly Averages of Analyses of Effluent of Filter No. 10.

[Parts per 100,000.]

Year.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. — Deg. F.	Ammonia.		Chlorine.	Nitrogen as		Total Nitrogen.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Free.	Albuminoid.		Nitrates.	Nitrites.			
1894,	160,000	62	.3379	.0230	13.99	2.8233	.0077	3.15	.20	8,717
1895,	146,700	53	.6572	.0459	10.72	2.4000	.0334	3.05	.46	15,580
1896,	112,800	54	.3209	.0451	8.96	3.0100	.0573	3.40	.35	5,266
Average,	139,800	56	.4387	.0380	11.22	2.7444	.0328	3.20	.34	9,888

Ashes or Cinders as Filtering Materials.

Towards the close of the year two filters were put in operation, one containing 4.5 feet in depth of coal ashes and the other containing the same depth of cinders; that is, coal ashes from which the finer material has been removed. Cinder filters are in use in many places in England for rapid filtration of sewage and are known as "roughing" filters, and the material is valuable for filtration purposes wherever land of a suitable character cannot be found, or for preliminary filtration before disposal upon land; but the first systematic experiment in this country upon their use for the complete purification of sewage by intermittent filtration was made by Prof. Chas. MacMillan of Princeton University, to whom we are indebted for the suggestion.

The two filters at the station are known as filters Nos. 80 and 81. Filter No. 80 is of ashes and receives sewage at the rate of 70,000 gallons per acre daily. The effluent of the filter has been clear and bright from the beginning of the experiment, but nitrification did not begin until after the close of the year. Filter No. 81 is of cinders and has received sewage at the rate of 550,000 gallons per acre daily. (For details see page 504.)

Average Purification of Lawrence Sewage by the Several Filters in 1896.

The following table gives the average results obtained by the filters receiving Lawrence sewage during 1896. The qualitative efficiency of the filters is shown by the percentage removal of organic matters of the applied sewage as indicated by the albuminoid ammonia and oxygen consumed.

Average Per Cent. of Albuminoid Ammonia, Oxygen consumed and of Bacteria removed from the Sewage by the Several Filters, with Average Rates of Filtration, 1896.

Number of Filter.	Dimensions of Filters.			Size of Sand		Manner of Filling.	In Operation Since	Average Rate of Filtration (Gallons per Acre Daily) Six Days in a Week.	Average Per Cent. Removed of		
	Depth of Sand (Inches).	Mean Diameter (Inches)	Area in Fractions of an Acre	Effective Size in Millimeters (10 Per Cent. Finer than)	Uniformity Coefficient.				Albuminoid Ammonia.	Oxygen Consumed.	Bacteria.
1, ...	63	200	$\frac{1}{200}$	0.48	2.4	Wet.	Jan. 10, 1888,	57,000	98	90	99.31
2, ...	60	200	$\frac{1}{200}$	0.08	2.0	Wet.	Jan. 19, 1887,	37,000	97	95	99.99
4, ...	60	200	$\frac{1}{200}$	0.04	2.7	Wet.	Dec. 19, 1887,	19,000	96	95	99.99
5 A, ...	63	200	$\frac{1}{200}$	1.40	2.4	Dry.	Sept. 14, 1891,	56,000	82	79	96.36
6, ...	44	200	$\frac{1}{200}$	0.35	7.8	Wet.	Jan. 12, 1888,	57,000	92	86	99.52
9 A, ...	60	200	$\frac{1}{200}$	0.17	2.0	Dry.	Nov. 18, 1890,	56,000	92	89	99.60
10, ...	60	200	$\frac{1}{200}$	0.35	7.8	Dry.	July 18, 1894,	118,000	94	92	97.60
15 B, ...	60	20	$\frac{1}{20000}$	5.10	2.0	Dry.	July 25, 1892,	355,000	83	83	95.25
16 B, ...	60	20	$\frac{1}{20000}$	5.10	2.0	Dry.	July 25, 1892,	316,000	73	70	91.97
21 A, ...	60	20	$\frac{1}{20000}$	1.60	2.4	Dry.	March 19, 1894,	344,000	89	86	96.41
66, ...	60	50	$\frac{1}{3000}$	5.10	2.0	Dry.	March 10, 1896,	352,000	51	40	77.44

WORK OF THE FILTERS FOR 1896.

Filters Nos. 1 to 10, inclusive, are each one two-hundredth of an acre in area and are out of doors; filters Nos. 12 to 21 A, inclusive, are one twenty-thousandth of an acre in area and within the buildings; Filter No. 59 is one ten-thousandth of an acre in area, Filter No. 66, one three-thousandth of an acre in area, and Filter No. 67, one six-thousandth of an acre in area. These three filters are also within the buildings.

Filter No. 1.

This filter, containing 60 inches in depth of coarse sand of an effective size of 0.48 millimeter, was in good condition at the beginning of the year and nitrification was active. On Nov. 15, 1895, the filter was covered with canvas stretched over a frame and this cover was removed on March 12. The surface was spaded over 6 inches deep on April 6 and again on October 23. During the last week of October following this last spading no sewage was applied to the filter.

The physical condition of the filter was excellent throughout the year, the applied sewage passed readily from the surface and the character of the effluent was satisfactory, as shown by the following table, giving the monthly averages of the weekly analyses: —

Effluent of Filter No. 1.

[Parts per 100,000.]

1896.	Quantity Applied.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface.	Appearance.		Ammonia.			Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Gallons per Acre Daily for Six Days in a Week.	Sewage.	Effluent.	Hours and Minutes.	Turbidity.	Color.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.		
January, .	60,000	45	42	9m.	Decided.	.39	1.1617	.1397	7.05	2.16	.1558	1.03	74,200
February, .	60,000	46	40	14m.	Slight	.84	0.8100	.0787	5.69	1.57	.1817	0.70	118,200
March, .	36,900	41	35	7m.	V. slight.	.21	0.2000	.0460	3.96	1.50	.2283	0.51	18,400
April, .	60,200	50	45	6m.	V. slight.	.20	0.3575	.0610	7.65	2.64	.1425	0.48	18,200
May, . .	60,200	59	59	3m.	V. slight.	.13	0.0215	.0345	10.51	4.49	.0024	0.27	10,500
June, . .	62,300	64	66	4m.	None.	.13	0.0078	.0291	12.05	3.87	.0002	0.19	6,900
July, . .	57,800	70	73	5m.	None.	.12	0.0120	.0253	13.71	4.13	.0013	0.22	2,600
August, .	60,000	72	75	6m.	None.	.10	0.0081	.0222	11.01	4.01	.0007	0.20	6,400
September,	60,000	63	68	18m.	V. slight.	.12	0.0382	.0243	10.55	3.47	.0005	0.21	20,000
October, .	48,900	54	56	48m.	Slight.	.14	0.2750	.0490	10.32	2.90	.0049	0.28	15,000
November,	56,200	45	52	55m.	Slight.	.14	0.2850	.0430	10.40	3.08	.0077	0.26	14,600
December,	60,000	40	44	31m.	Decided.	.43	1.1175	.1090	9.19	1.79	.0213	0.69	49,000
Average,	56,800	56	55	17m.	V. slight.	.20	0.3646	.0543	9.35	2.96	.0618	0.43	30,300

Sewage applied, 500 gallons six times a week, except from October 23 to November 6, when filter was allowed to rest. March 1 to 12, experiment interrupted by freshet. Surface raked 1 inch deep each week, except twice in January, once in December and during period of rest. Surface spaded 6 inches deep April 6 and October 23. March 12, canvas cover removed. June 13 to August 31, a trap 18 inches high was attached to effluent pipe. During March, 6½ inches of snow removed; during December, 6 inches of snow and 4½ inches of ice removed.

Filter No. 2.

This filter contains 60 inches in depth of fine sand of an effective size of 0.08 millimeter, with two trenches, 1 foot wide and 2 feet deep, of medium fine sand of an effective size of 0.19 millimeter. It has been in good condition throughout the year and has given a clear, bright, well-purified effluent.

The following table gives the monthly averages of the analyses of the effluent, and the notes below give the management of the filter during the year: —

Effluent of Filter No. 2.

[Parts per 100,000.]

1896.	Quantity Applied.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Gallons per Acre Daily for Six Days in a Week	Sewage.	Effluent.	Hours and Minutes.	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	34,100	50	41	7h. 30m.	V. slight.	.15	0.9760	.0432	3.15	2.05	.0152	.40	261
February, .	40,000	46	41	6h. 16m.	V. slight.	.15	1.3740	.0420	5.61	1.16	.0072	.29	70
March, .	29,200	48	37	1h. 34m.	None.	.12	0.0267	.0267	4.66	1.55	.0018	.24	15
April, .	40,000	50	43	52m.	None.	.11	0.5325	.0330	6.19	2.90	.0021	.18	26
May, . .	40,000	60	55	30m.	None.	.09	0.0992	.0247	10.27	4.34	.0000	.18	58
June, . .	40,000	64	62	15m.	None.	.08	0.0034	.0229	10.17	4.30	.0000	.17	12
July, . .	37,000	72	68	9m.	None.	.09	0.0032	.0256	17.04	4.23	.0000	.19	9
August, .	40,000	74	72	12m.	None.	[illegible]	[illegible]	.0216	17.10	4.18	.0000	.20	37
September,	40,000	64	68	42m.	None.	.12	0.0028	.0185	10.18	4.00	.0000	.17	15
October, .	31,100	54	60	1h. 28m.	None.	.11	0.0024	.0192	9.66	3.70	.0000	.14	9
November,	36,800	48	54	1h. 25m.	None.	.07	0.0014	.0160	9.70	3.34	.0002	.12	20
December,	35,600	45	46	2h. 16m.	None.	.12	0.1065	.0240	9.00	3.55	.0021	.21	54
Average,	37,000	56	54	1h. 56m.	None.	.11	0.2360	.0267	9.81	3.28	.0027	.21	49

Sewage applied, 200 gallons six times a week, except from October 23 to November 6, when filter was allowed to rest March 1 to 9, experiment interrupted by freshet. Surface of trenches raked 1 inch deep each week, except twice in January, once in February and once in December February 6, surface of trenches dug over to a depth of 4 inches. March 21 and October 27, sand removed from trenches; sides of trenches scraped and raked, and bottom of trenches dug over to a depth of from 3 to 5 inches; sand replaced in trenches. August 1, cut grass and weeds on surface; weight of grass and weeds 170 pounds 8 ounces. During January, 9½ inches of snow removed from entire surface and 4½ inches of ice from surface of trenches; during February, 14 inches of snow removed from entire surface and 2¾ inches of ice from trenches; during March, 6¼ inches of snow removed from surface; during December, 7½ inches of snow removed from surface and 3¾ inches of ice from trenches.

Filter No. 4.

This filter contains 60 inches in depth of fine river silt of an effective size of 0.04 millimeter, with two circular trenches, about 14 inches wide and 12 inches deep, of coarse sand of an effective size

of 0.48 millimeter. The surface level of the trenches is a few inches lower than the surface of the remainder of the filter and upon it the sewage is applied. The filter has been in good condition throughout the year, has taken the applied sewage readily and given a clear, bright and well-purified effluent. During the summer the surface, with the exception of the trenches, was covered with a heavy growth of coarse grass; this was cut during August and the dry weight was at the rate of three tons of hay per acre.

The following table gives the monthly averages of the analyses and the notes below the management of the filter during the year: —

Effluent of Filter No. 4.

[Parts per 100,000.]

1896.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	19,300	50	44	8h. 5m	None.	.13	0.0021	.0152	7.60	1.35	.0028	.17	82
February, .	19,200	46	41	12h. –	V. slight	.15	0.0376	.0526	7.80	0.62	.0069	.29	100
March, .	15,400	45	38	42m.	None.	.27	0.1907	.0486	6.79	0.37	.0008	.25	288
April, .	20,000	49	43	28m.	None.	.21	0.6525	.0540	6.46	1.16	.0202	.30	50
May, . .	20,000	51	54	15m.	None.	.12	1.0680	.0688	9.79	3.79	.0152	.23	123
June, . .	20,000	66	62	10m.	None.	.08	0.7233	.0293	13.38	5.02	.0050	.16	14
July, . .	17,800	73	68	6m.	None.	[illegible]	0.0027	.0211	14.28	2.65	.0021	.19	22
August, .	20,000	74	73	9m.	None.	.08	0.0031	.0158	16.80	3.96	.0000	.15	11
September,	20,000	64	60	17m	None.	.08	0.0030	.0160	13.33	3.38	.0000	.16	107
October, .	17,800	54	61	1h. 3m.	None.	.10	0.0020	.0144	9.98	3.34	.0000	.12	17
November,	19,200	48	56	1h. –	None.	.07	0.0012	.0106	9.60	3.43	.0000	.10	38
December,	19,300	49	43	1h. 58m.	None.	.07	0.0033	.0106	9.02	3.88	.0000	.10	36
Average,	19,000	57	54	2h. 11m.	None.	.12	0.2291	.0281	10.81	2.78	.0062	.19	71

Sewage applied, 200 gallons three times a week, except from October 23 to November 6, when filter was allowed to rest. March 1 to 9, experiment interrupted by freshet. Surface of trenches raked 1 inch deep each week, except once in January and once in December. February 8, surface of trenches dug over to a depth of 4 inches. March 20 and October 27, sand removed from trenches, sides of trenches scraped and raked, and bottoms of trenches dug over to a depth of from 3 to 5 inches; sand replaced in trenches. August 1, cut grass and weeds on surface; weight of grass, 170 pounds 14 ounces. During January, 7½ inches of snow removed from entire surface and 1½ inches of ice from trenches; during February, 15 inches of snow removed from surface and 1 inch of ice from trenches; during March, 12 inches of snow removed from surface; during December, 8½ inches of snow removed from surface and 4½ inches of ice from trenches.

Filter No. 5 A.

This filter, of fine gravel stones of an effective size of 1.40 millimeters, has been in good condition and taken the applied sewage readily throughout the year. While the effluent is not equal in quality to effluents from the filters of finer material, yet it has contained on an average only 20 per cent. of the organic matter of the applied sewage.

The monthly averages of the analyses of the effluent are given in the following table and notes in regard to the operation of the filter are presented below: —

Effluent of Filter No. 5 A.

[Parts per 100,000.]

1896.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	60,000	47	41	6h. 37m.	Great.	.45	1.8280	.2168	10.38	1.42	.0760	1.46	441,600
February, .	57,600	46	39	2h. 11m	Slight.	.36	1.6471	.1646	8.42	1.43	.2029	1.01	227,000
March, .	40,800	46	37	15m	Decided	.40	1.0067	.1120	6.07	1.73	.2867	0.91	255,000
April, .	60,000	50	45	37m.	Decided.	.38	0.9550	.1230	9.58	2.96	.2300	0.89	152,000
May, . .	60,000	61	59	8m.	Decided	.32	0.4960	.1116	16.04	4.76	.0062	0.64	[illegible]
June, . .	60,000	66	67	12m.	Slight.	.21	0.2600	.1240	24.24	4.64	.0015	0.66	48,700
July, . .	53,300	73	73	10m.	V. slight.	.16	0.1627	.0620	18.13	3.86	.0013	0.29	68,100
August, .	56,800	74	76	12m.	Decided.	.21	0.4900	.1360	14.09	4.06	.0026	0.53	132,000
September,	60,000	65	68	27m.	Decided.	.25	0.7650	.1340	12.14	3.19	.0014	0.78	151,000
October, .	48,100	54	55	20m.	Decided	.34	1.1600	.2150	11.87	3.33	.0017	1.21	57,000
November,	55,200	48	53	24m	Decided	.23	1.6000	.1660	13.01	2.72	.0090	1.15	156,000
December,	59,400	47	44	26m.	Decided	.29	1.3800	.1640	[illegible]	2.31	.0216	0.81	33,700
Average,	56,100	56	55	1h. -	Decided.	.30	0.9807	.1424	12.76	3.03	.0700	0.86	159,600

Sewage applied, January 1 to 6, 150 gallons twelve times a week; January 7 to 14, 600 gallons three times a week; January 15 to December 31, 300 gallons six times a week, except from October 23 to November 6, when filter was allowed to rest. March 1 to 10, experiment interrupted by freshet. Surface raked 1 inch deep each week, except once in January and twice in December. Surface dug over 6 inches deep on April 27 and November 17. June 13 to August 31, a trap 18 inches high was attached to effluent pipe. During January, 8½ inches of snow and 1¾ inches of ice removed from surface; during February, 17 inches of snow and 1¾ inches of ice removed; during March, 12½ inches of snow removed; during December, 10½ inches of snow and 2½ inches of ice removed.

Filter No. 6.

This filter contains 44 inches in depth of mixed coarse and fine sand of an effective size of 0.35 millimeter. It has been kept in good physical condition throughout the year, has disposed of the applied sewage readily and has given an effluent of a satisfactory quality.

The following table presents the rate of filtration, the monthly averages of the analyses of the effluent and the notes below give the details of operation : —

Effluent of Filter No. 6.

[Parts per 100,000.]

1896.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, .	60,300	40	39	6h. 16m.	Decided.	.42	[illegible]	.1845	8.13	0.66	.1960	[illegible]	109,100
February, .	61,600	46	39	5h. 18m.	Slight.	.37	1.7549	.1100	6.24	1.17	.2357	0.77	64,000
March, .	43,800	45	37	35m.	Slight.	.38	1.1133	.0853	5.24	1.22	.3933	1.29	[illegible]
April, .	57,300	49	45	17m.	V. slight.	.30	1.0230	.0724	7.33	2.78	.5600	1.09	12,700
May, . .	60,000	60	60	11m.	V. slight.	.15	0.0601	.0417	13.11	4.34	.0340	0.33	3,500
June, . .	60,000	65	65	13m.	V. slight.	.20	0.0058	.0305	12.18	4.26	.0000	0.25	2,600
July, . .	56,700	72	73	18m.	V. slight.	.15	0.0272	.0307	16.76	3.77	.0001	0.26	1,200
August, .	60,000	74	76	22m.	None.	.12	0.0141	.0236	14.62	3.69	.0001	0.26	3,100
September,	60,000	65	66	19m.	V slight.	.14	0.0318	.0339	11.59	3.15	.0003	0.22	4,200
October, .	48,900	54	47	34m	None.	.14	0.1800	.0320	9.35	2.91	.0010	0.21	7,100
November,	55,400	47	51	32m.	None.	.13	0.2750	.0350	12.21	3.31	.0003	0.26	6,800
December,	66,100	46	42	1h 53m	Slight.	.34	1.1300	.1020	9.23	1.50	.0875	0.70	10,900
Average,	56,600	56	55	1h. 24m.	V slight.	.24	0.6067	.0652	10.49	2.73	.1266	0.56	21,300

Sewage applied, 300 gallons six times a week, except from January 6 to 14, when it was applied 600 gallons three times a week, and from October 23 to November 6, when filter was allowed to rest. March 1 to 9, experiment interrupted by freshet. Surface raked 1 inch deep each week, except twice in December. Surface dug over 6 inches deep March 31 and August 31; from 6 to 8 inches deep on October 23, and 4 inches deep December 29. During January, 9½ inches of snow and 3¼ inches of ice removed from surface; during February, 13½ inches of snow and 3½ inches of ice removed, during March, 12½ inches of snow removed; during December, 17 inches of snow and 8½ inches of ice removed.

Filter No. 9 A.

This filter contains 5 feet in depth of sand of an effective size of 0.17 millimeter. It has been in good condition throughout the year, has taken the applied sewage readily and has given an effluent of a satisfactory quality. The average rate of filtration has been 56,300 gallons per acre daily.

The following table gives the monthly averages of the analyses and the notes below give the details of operation for the year: —

Effluent of Filter No. 9 A.

[Parts per 100,000.]

1896.	Quantity Applied — Gallons per Acre Daily for Six Days in a Week	Temperature. Deg. F. — Sewage.	Temperature. Deg. F. — Effluent.	Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance. — Turbidity.	Appearance. — Color.	Ammonia. — Free.	Ammonia. — Albuminoid.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, .	56,300	47	40	13h 17m.	Decided.	.42	2.4750	.1670	8.78	0.99	.0750	1.16	69,800
February, .	59,200	46	37	7h. 4m	Slight.	.53	1.9629	.1986	6.82	0.89	.0714	0.68	92,000
March, .	43,800	45	37	2h. –	Slight.	.40	0.7000	.0787	5.74	1.16	.1628	0.71	19,300
April, .	53,100	48	45	28m.	V. slight.	[illegible]	0.2050	.0438	7.67	4.42	.1016	0.39	4,900
May, . .	60,000	[illegible]	57	14m.	V. slight.	.16	0.0142	.0328	10.54	4.73	.0003	0.26	1,124
June, . .	61,500	64	[illegible]	11m.	None.	.12	0.0064	.0242	8.61	4.30	.0002	0.20	354
July, . .	57,800	71	73	3m.	V. slight.	.12	0.0120	.0263	12.44	4.29	.0004	0.21	398
August, .	60,000	75	74	7m	None.	.11	0.0037	.0216	10.38	4.14	.0001	0.20	48
September,	60,000	64	68	31m	V. slight.	.10	0.0266	.0191	6.17	3.02	.0002	0.16	186
October, .	48,900	54	56	1h 39m	None.	.12	0.0289	.0176	9.26	3.20	.0004	0.17	96
November,	55,600	47	52	1h. 51m.	None.	.13	0.1400	.0260	9.92	3.45	.0001	0.27	168
December,	59,400	45	44	16h 36m.	Decided.	.43	2.0775	.1440	9.18	1.82	.0238	0.92	14,000
Average,	56,300	55	54	3h. 40m	V. slight.	.24	0.6481	.0606	8.99	3.19	.0364	0.47	17,700

Sewage applied, 300 gallons six times a week, except from January 1 to 15, when it was applied 600 gallons three times a week, and from October 23 to November 6, when filter was allowed to rest. March 1 to 9, experiment interrupted by freshet. Surface raked 1 inch deep each week. Surface dug over 2 inches deep on February 4; 6 inches deep on March 31, June 15, August 31; 6 to 8 inches deep on October 23. From February 7 to March 31 four trenches 2 feet wide and 3 inches deep were cut in the surface. During January, 7 inches of snow and 6¾ inches of ice removed from surface; during February, 13¼ inches of snow and ¾ inch of ice removed; during March, 15¼ inches of snow removed; during December, 14 inches of snow and 8¼ inches of ice removed.

Filter No. 10.

This filter is one two-hundredth of an acre in area and contains 5 feet in depth of mixed coarse and fine sand of an effective size of 0.35 millimeter. No gravel underdrains are beneath the sand except directly above and around the outlet pipe. A partition, extending 3 feet below the surface, separates the quarter of the surface farthest from the underdrains from the remainder of the surface. To this quarter of the surface the sewage has been applied during 1896 at a rate of 120,000 gallons per acre daily for this quarter area, or 30,000 for the entire area of the filter. With this rate and method of construction and operation very satisfactory results have been obtained during the entire year.

The following table gives the monthly averages of the analyses and the notes below state the details of operation of the filter: —

Effluent of Filter No. 10.

[Parts per 100,000.]

1896.	Quantity Applied — Gallons per Acre Daily for Six Days in a Week.	Temperature Deg. F. — Sewage.	Temperature Deg. F. — Effluent.	Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance. — Turbidity.	Appearance. — Color.	Ammonia. — Free.	Ammonia. — Albuminoid.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	30,000	45	40	5h. –	V. slight.	.34	1.0480	.0884	7.52	1.05	.1300	.71	5,206
February,	30,000	45	38	4h. 16m.	Slight.	.29	0.9615	.1000	5.90	1.05	.1375	.65	41,067
March,	21,900	43	35	1h. 20m.	V. slight.	.20	0.5300	.0547	6.36	1.56	.2533	.70	12,300
April,	26,400	48	42	43m.	V. slight.	.16	0.2040	.0436	7.84	3.77	.1103	.37	1,382
May,	30,000	60	57	8m.	None.	.12	0.0373	.0313	10.41	4.72	.0005	.21	190
June,	30,400	64	66	5m.	None.	.13	0.0240	.0427	9.99	4.85	.0003	.21	129
July,	28,900	72	73	4m.	V. slight.	.12	0.0847	.0271	12.41	3.55	.0001	.20	115
August,	30,000	73	74	7m.	V. slight.	.11	0.0392	.0205	9.77	3.65	.0001	.21	109
September,	30,000	65	60	51m.	V. slight.	.08	0.0565	.0257	9.90	3.36	.0003	.19	245
October,	24,400	54	61	16m.	None.	.10	0.0058	.0184	8.66	3.61	.0010	.15	213
November,	27,600	47	53	21m.	None.	.12	0.1600	.0310	10.89	2.65	.0060	.19	355
December,	25,900	45	45	1h. –	V. slight.	.20	0.6700	.0585	9.26	2.29	.0470	.41	1,754
Average,	28,200	55	54	1h. –	V. slight.	.16	0.3209	.0461	8.90	3.01	.0673	.35	5,366

Sewage applied, 150 gallons six times a week, except from October 23 to November 6, when filter was allowed to rest. March 1 to 9, experiment interrupted by freshet. That part of surface to which sewage is applied has been raked 1 inch deep each week, except once in January and once in December. March 31, the entire surface dug over 6 inches deep; August 31, surface to which sewage is applied dug over 6 inches; October 23, surface to which sewage is applied dug over 8 inches and the remainder of surface 6 inches. October 23, the grass and weeds pulled from the entire surface. During January, 3 inches of snow and 1 inch of ice removed from that part of surface to which sewage is applied; during February, 16½ inches of snow and ½ inch of ice removed; during March, 13½ inches of snow removed; during December, 12 inches of snow and 4½ inches of ice removed.

Filters Nos. 12 A, 15 B and 16 B.

Filter No. 12 A contains 60 inches in depth of sand of an effective size of 0.19 millimeter, and filters Nos. 15 B and 16 B contain 65 inches in depth of gravel stones of an effective size of 5.40 millimeters. Filter No. 12 A receives as much of the effluents of filters 15 B and 16 B as it is capable of disposing of, and, during 1896, its average rate of filtration has been 443,000 gallons per acre daily, with a maximum rate of 676,000 gallons in June. The quantitative capacity of the filter decreased during the first four months of the year. On April 9 the surface was spaded to a depth of 8 inches and during the greater part of May the filter was allowed to rest. During the following five months it was capable of receiving nearly the entire volume of the effluents of filters Nos. 15 B and 16 B. In November it again became clogged and was spaded over to a depth of 6 inches four times between November 14 and December 2, and upon

December 3 the upper foot of material was spaded over and thoroughly mixed.

Filters Nos. 15 B and 16 B were receiving sewage at the rate of 480,000 gallons per acre daily during the first months of the year. At this rate the filters became clogged and were allowed to rest with continuous aeration from May 1 to 11, inclusive. This air drawn through the filters at the rate of one gallon every four minutes improved the condition of the filters but slightly, and, beginning May 12, city water was applied to the filters in twelve applications daily and at a total rate of 120,000 gallons daily, the filter being aerated for eight hours each night. With this method of operation, which was continued for one week, the nitrogen stored in Filter No. 15 B was rapidly nitrified and removed as nitrates in solution, but Filter No. 16 B was so badly clogged that finally the entire filtering material had to be removed, washed and replaced. Since June 1 the filters have been operated at an average rate of 360,000 gallons per acre daily, and both were in good condition at the end of the year.

The following tables give the monthly averages of the analyses and the notes below the details of operation during the year: —

Effluent of Filter No. 12 A.

[Parts per 100,000.]

1896.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	351,000	46	49	6h. –	None.	.21	.0082	.0218	8.29	1.72	.0002	.29	163
February, .	403,000	46	49	2h. 37m.	None.	.19	.0011	.0167	7.15	1.43	.0000	.26	80
March, .	262,000	39	46	8h. 30m.	None.	.17	.0077	.0192	6.33	1.85	.0001	.22	248
April, .	386,000	52	61	1h. 35m.	None.	.24	.0571	.0235	8.46	1.55	.0002	.23	990
May, . .	62,000	–	–	– –	–	–	–	–	–	(6.93)	–	–	–
June, . .	676,000	65	65	44m.	None.	.18	.0105	.0224	10.72	2.65	.0002	.21	374
July, . .	659,000	70	71	1h. 15m.	V slight.	.20	.0018	.0255	16.32	2.49	.0000	.26	331
August, .	660,000	77	74	53m	V. slight.	.17	.0021	.0186	12.16	3.19	.0000	.26	202
September,	632,000	62	62	1h. 7m	V slight.	.15	.0089	.0207	11.07	2.82	.0000	.22	916
October, .	594,000	51	52	54m.	None	.14	.0030	.0198	12.00	2.90	.0000	.22	1,120
November,	409,000	51	53	1h. 10m.	None.	.10	.2204	.0208	9.60	4.07	.0006	.18	286
December,	204,000	45	48	– –	None.	.10	.0056	.0236	9.80	3.33	.0000	.17	635
Average,	443,000	55	56	2h. –	None.	.17	.0272	.0211	10.16	2.50	.0001	.22	454

Six gallons of effluent of filters Nos. 15 and 16 applied nineteen times a week, January 1 to March 19; 6 gallons of effluent of No 15 applied twenty-four times a week, March 20 to April 20; 6 gallons of effluent of Nos. 15 and 16 twenty-four times a week, April 21 to May 1, 6 gallons twelve times a week, May 22 to May 30; all the effluent of Nos. 15 and 16, twenty-four times a week, June 1 to December 2; 5 gallons of No. 15 effluent twelve times a week, December 2 to December 31. March 1 to 10 and April 17 to 20, experiment interrupted by freshet May 1 to 21 and November 17 to 22, filter rested. Surface raked 3 inches deep twice each week. Sand disturbed 8 inches deep on April 9 and 6 inches deep on the following dates: November 14, 17, 27, December 2. December 8, 1 foot of sand removed, thoroughly mixed and replaced in tank.

Effluent of Filter No 15 B.

[Parts per 100,000.]

[redacted]	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F		Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	480,000	48	47	None.	Decided.	.41	0.6640	.1628	9.08	1.50	.0172	1.02	296,000
February, .	480,000	47	47	None.	Decided.	.44	0.5325	.1295	6.49	0.78	.0263	1.40	235,000
March, .	333,800	45	43	None.	Decided.	.56	1.3000	.2683	6.64	0.86	.0053	0.86	449,000
April, .	426,200	52	50	None.	Great.	.80	1.4875	.2075	8.17	0.73	.0053	1.00	416,000
May, . .	80,400	63	65	None.	Decided.	.66	0.5500	.1100	1.71	5.33	.0070	0.30	6,500
June, . .	383,100	68	64	None.	Decided.	.69	0.7667	.1193	10.66	2.64	.0057	0.66	120,700
July, . .	346,700	74	70	None.	Decided.	.68	0.9050	.1580	15.53	2.05	.0095	0.59	128,500
August, .	360,000	75	77	None.	Decided.	.57	0.3400	.0850	12.09	2.80	.0200	0.46	134,000
September,	360,000	65	61	None.	Decided.	.36	0.3050	.0880	11.29	3.05	.0120	0.41	182,500
October, .	360,000	55	51	None.	Decided	.33	0.2900	.0930	11.55	3.78	.0105	0.57	141,500
November,	288,000	51	51	None.	Decided	.33	0.4600	.1080	12.87	3.36	.0095	0.79	265,000
December,	360,000	47	46	None.	Decided.	.27	0.2940	.0926	9.50	3.15	.0098	0.56	124,400
Average,	354,900	58	56	None.	Decided	.50	0.6571	.1349	9.66	2.50	.0117	0.72	208,400

Sewage applied, 2 gallons seventy-two times a week, January 1 to May 1; ½ gallon of city water seventy-two times a week, May 12 to 21; ½ gallon of sewage seventy-two times a week, May 22 to 30; 1 gallon of sewage seventy two times a week, June 1 to 7, 2 gallons of sewage seventy-two times a week, June 8 to 16; 1½ gallons of sewage seventy two times a week, June 17 to December 31. May 1 to 11 and November 17 to 22, filter allowed to rest. March 1 to 10 and April 17 to 20, experiment interrupted by freshet. Filter was aspirated two hours each morning, January 1 to April 30; continuously, May 1 to 11; eight hours each night, May 12 to December 31, except from November 17 to 22, when aspirator was run continuously. March 10, top 6 inches of gravel removed, washed and replaced. Surface raked 3 inches deep once each week. Surface spaded 12 inches deep May 4 and 6 inches deep November 17. Underdrains washed out with city pressure, October 21 and December 16.

Effluent of Filter No. 16 B.

[Parts per 100,000.]

1896.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	480,000	48	46	None	Decided.	0.37	0.8180	.1886	9.38	1.24	.0312	1.11	594,000
February, .	480,000	47	44	None.	Great	0.42	1.1356	.2020	6.39	0.36	.0165	1.97	494,000
March, .	110,800	45	55	None.	Great.	0.64	0.2300	.2500	6.32	0.01	.0020	1.70	184,000
April, .	186,200	52	55	None.	Great.	0.67	2.3167	.3367	9.23	2.66	.0083	1.33	1,099,600
May, . .	78,800	63	65	None.	Great.	4.50	1.3000	.2500	2.62	0.06	.0000	1.96	87,000
June, . .	383,100	68	65	None.	Decided.	0.75	2.3633	.2187	9.27	1.08	.0097	1.05	272,300
July, . .	340,000	74	70	None.	Great.	0.96	2.5000	.3000	15.13	0.32	.0100	1.37	319,000
August, .	360,000	75	76	None.	Decided	0.34	0.2200	.0620	13.06	2.80	.0170	0.45	71,000
September,	360,000	66	62	None.	Decided	0.57	1.2750	.2310	11.02	1.60	.0145	1.00	430,500
October, .	360,000	55	61	None.	Decided	0.67	1.4900	.1310	11.06	1.91	.0060	1.07	99,500
November,	288,000	51	50	None.	Decided	0.48	1.5900	.1770	13.06	3.02	.0070	1.21	401,000
December,	360,000	47	44	None.	Decided.	0.42	1.0450	.1796	9.22	2.93	.0066	0.83	220,800
Average,	315,600	58	56	None.	Decided	0.90	1.3575	.2106	9.65	1.50	.0107	1.26	352,400

Sewage applied, 2 gallons seventy-two times a week, January 1 to May 11, except from March 18 to April 19 and May 1 to 11, when filter was allowed to rest; May 12 to 21, city water applied ½ gallon seventy-two times a week; May 22 to 30, sewage applied ½ gallon seventy two times a week; June 1 to 7, 1 gallon applied seventy-two times a week; June 8 to 16, 2 gallons applied seventy-two times a week; June 17 to December 31, 1½ gallons seventy-two times a week, except from November 17 to 22, when filter was allowed to rest. March 1 to 10, experiment interrupted by freshet. Filter was aspirated eight hours each night except during periods of rest, when aspirator was run continuously. March 10, top 6 inches of gravel removed, washed and replaced. April 21 to July 21, trap removed during the day, and attached to faucet only while filter was being aspirated during the night. July 22, filter was emptied and washed out, and gravel washed and replaced. Surface raked 3 inches deep once each week. Surface spaded 12 inches deep on May 4 and 6 inches deep on November 17. May 20, filter flushed out with city water from below for one hour. Underdrains washed out with city pressure October 21 and December 16.

Filter No. 13 A.

This filter contains 60 inches in depth of medium fine sand of an effective size of 0.19 millimeter, and has received the supernatant liquid from sewage which has been allowed to settle for four hours. The average rate of filtration during 1896 has been 152,000 gallons per acre daily. The filter has been in good condition during the year, has disposed of the applied sewage readily and its effluent has been of a satisfactory quality.

The following table gives the monthly averages of the analyses and the notes below the details of operation of the filter: —

Effluent of Filter No. 13 A.

[Parts per 100,000.]

1896.	Quantity Applied — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F		Length of Time Sewage Remained on Surface. — Hours and Minutes	Appearance.		Ammonia.		Chlorine.	Nitr[illegible] as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January,	160,000	49	45	14m.	None.	.13	.0748	.0256	8.56	3.46	.0057	.22	326
February,	160,000	49	50	15m.	None.	.12	.0137	.0203	7.40	2.45	.0003	.19	321
March,	111,000	46	45	16m.	None.	.12	.0518	.0175	6.42	3.03	.0008	.15	323
April,	141,500	56	51	18m.	None.	.13	.0667	.0311	8.24	4.07	.0016	.15	797
May,	160,000	66	61	13m.	None.	.13	.0770	.0315	9.65	4.02	.0007	.20	[illegible]
June,	166,000	71	65	11m.	None.	.12	.1420	.0320	10.34	3.24	.0006	.19	244
July,	154,000	77	70	12m.	None.	.12	.0873	.0242	14.26	2.96	.0003	.19	77
August,	160,000	77	74	10m.	None.	.12	.0091	.0273	11.14	3.87	.0004	.22	102
September,	160,000	68	67	11m.	None.	.11	.0104	.0254	10.66	2.64	.0000	.17	65
October,	160,000	56	57	14m.	None.	.13	[illegible]	.0325	12.88	3.05	.0001	.21	83
November,	129,000	54	53	15m.	None.	.09	.2897	.0305	9.16	3.79	.0003	[illegible]	407
December,	160,000	49	47	13m.	None.	.13	.2420	.0328	9.40	3.42	.0001	.24	274
Average,	151,700	60	57	14m.	None.	.12	.0969	.0276	9.82	3.34	.0009	.19	316

Settled sewage applied, 4 gallons twelve times a week. No sewage applied November 17 to 22. March 1 to 10 and April 17 to 20, experiment interrupted by freshet. Surface raked 3 inches deep twice each week. Surface dug over 5 inches deep April 9, and 6 inches deep on the following dates: June 27, August 1, November 17.

Filter No. 14 A.

This filter contains 60 inches in depth of medium fine sand of an effective size of 0.19 millimeter, and has received since June 1, 1894, sewage which has been first strained through a shallow layer of coke breeze. The average rate of filtration during 1896 has been 280,000 gallons per acre daily. This rate was too great, considering the strength of the applied sewage, and resulted in clogging the filter quite seriously towards the end of the year. From December 8 to 28, inclusive, city water was applied at the rate of 80,000 gallons per acre daily and considerable of the stored organic matter was removed.

The following table gives the monthly averages of the analyses and the notes below the details of operation of the filter: —

Effluent of Filter No. 14 A.

[Parts per 100,000.]

1896.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January,	320,000	49	47	[illegible]	V. slight.	.22	0.2544	.0395	8.18	2.86	.0054	.35	1,999
February,	266,600	49	47	1h. 14m.	V. slight.	.43	0.6949	.0593	6.78	1.57	.0168	.61	5,465
March,	221,500	46	42	40m.	V. slight.	.15	0.0149	.0217	5.98	1.92	.0000	.22	943
April,	283,000	56	53	31m.	V. slight	.29	0.0429	.0375	8.33	2.36	.0010	.32	1,946
May,	320,000	66	[illegible]	16m.	V. slight.	.16	0.0422	.0829	11.65	3.47	.0002	.29	1,411
June,	332,400	71	64	18m.	V. slight.	.24	0.2735	.0498	15.45	3.77	.0012	.31	1,342
July,	302,200	77	70	17m.	V. slight.	.17	0.0056	.0830	15.96	3.28	.0000	.24	849
August,	318,600	77	73	15m.	None.	.16	0.0028	.0330	13.91	3.06	.0008	.29	1,413
September,	320,000	68	66	19m.	None.	.16	0.0070	.0334	14.34	3.34	.0000	.26	221
October,	320,000	65	60	42m.	V. slight	.30	0.0017	.0675	12.75	2.07	.0003	.54	660
November,	249,600	54	52	1h. 47m.	None.	.23	0.0620	.0380	[illegible]	2.67	.0010	[illegible]	1,560
December,	111,000	49	47	1h. 16m.	None.	.84	1.4663	.0744	6.93	3.13	.0017	.44	3,442
Average,	279,900	60	56	41m.	V. slight.	.24	0.2909	.0483	10.78	2.79	.0025	.34	1,771

Four gallons of sewage strained through coke applied twenty-four times a week, January 1 to December 7; 1 gallon of city water twelve times a week, December 8 to 28; 4 gallons of sewage twenty-four times a week, December 29 to 31. No sewage applied February 19 to 23 and November 17 to 22, March 1 to 10 and April 17 to 20, experiment interrupted by freshet. Surface raked 3 inches deep twice each week. Surface dug over 8 inches deep, February 19, April 9, December 7, and 6 inches deep on the following dates: June 27, August 1, November 10 and 17.

Filter No. 19.

This filter contains 60 inches in depth of medium fine sand of an effective size of 0.19 millimeter, and has received the supernatant liquid from sewage which has been allowed to settle for four hours after treatment with sulphate of alumina at the rate of 1,000 pounds per 1,000,000 gallons. The filter has received this clarified sewage at an average rate of 190,000 gallons and has given a satisfactory effluent.

Effluent of Filter No. 19.

[Parts per 100,000.]

1896.	Quantity Applied.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Gallons per Acre Daily for Six Days in a Week.	[redacted]wage.	Effluent.	Hours and Minutes.	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrit[redacted]		
January, .	200,000	49	42	23m.	None.	.16	.3625	.0430	8.22	2.76	.0388	[redacted]	1,086
February, .	200,000	49	43	18m.	V. slight.	.15	.5490	.0305	7.61	2.16	.0652	.30	2,503
March, .	186,500	44	39	23m.	V. slight.	.13	.7073	.0307	6.88	1.97	[redacted]	.26	1,520
April, .	176,900	56	48	25m.	None.	.15	.5825	.0350	[redacted]	3.20	.0576	.28	376
May, . .	200,000	66	61	15m.	None.	.14	.1450	.0390	8.99	3.29	.0050	.26	39
June, . .	207,700	71	65	10m.	None.	.14	.0935	.0297	10.78	4.36	[redacted]	.22	48
July, . .	192,500	77	72	18m.	None.	.14	.0541	.0321	15.66	4.68	.0000	.22	26
August, .	200,000	77	72	12m.	None.	.13	.0408	.0236	9.97	4.20	.0001	.25	57
September,	200,000	66	67	9m.	None.	.13	.0046	.0222	10.05	3.34	[redacted]	.21	24
October, .	200,000	55	56	17m.	None.	.12	.2745	.0278	14.48	3.57	[redacted]	[redacted]	61
November,	160,000	54	49	17m	None.	.12	.5600	.0350	9.35	3.32	.0072	.25	168
December,	200,000	48	48	18m	V slight	.12	.7216	.0472	9.64	2.68	.0248	.30	309
Average,	189,600	60	54	17m.	None.	.14	.3779	.0333	9.92	3.28	.0224	.25	521

Sewage applied, 5 gallons twelve times a week, except from November 17 to 22, when filter was allowed to rest. March 1 to 10 and April 17 to 20, experiment interrupted by freshet. Surface raked 3 inches deep twice each week. Surface spaded over 8 inches deep on April 9, and 6 inches deep on June 27, August 1 and November 17.

Filter No. 21 A.

This filter contains 60 inches in depth of fine sifted gravel of an effective size of 1.60 millimeters. It was put in operation March 19, 1894, and since July 7 of the same year has had a current of air drawn downward through it at the rate of about one gallon in four minutes and for daily periods varying from ten to sixteen hours.

The prescribed rate of filtration has been 360,000 gallons per acre daily, and during 1896 the actual rate has been 344,000 gallons per acre daily. An exceedingly satisfactory effluent has been obtained, but the filter is gradually becoming clogged with organic matter, notwithstanding the aeration.

The following table gives the average analyses and the notes below the details of operation of the filter: —

Effluent of Filter No. 21 A.

[Parts per 100,000.]

1896.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F		Average Number of Applications which remained on Surface less than 30 Minutes	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	360,000	48	41	12	Decided	.27	.2810	.0920	8.67	2.90	.0038	0.67	129,500
February, .	360,000	47	42	11	Decided	.33	.0800	0780	5.97	2.52	.0683	1.42	64,250
March, .	249,200	45	38	12	Decided	.32	.2107	.0767	6.67	1.96	.0122	0.45	220,700
April, .	346,200	52	48	7	Slight	[illegible]	.0560	.0828	7.88	2.92	.0068	0.44	76,800
May, . .	360,000	63	62	[illegible]	V. slight.	.29	.0249	0585	9.68	3.95	.0005	0.36	18,000
June, . .	373,800	68	67	11	Slight.	.25	.0549	0602	10.60	4.36	.0007	0.27	116,500
July, . .	346,700	74	71	12	Decided.	.36	[illegible]	.0930	15.61	4.09	.0017	0.54	320,000
August, .	360,000	75	76	12	Decided.	32	0530	.0530	10.29	3.88	.0014	0.35	92,000
September,	360,000	65	68	12	Decided.	.32	.0240	.0680	7.86	3.25	.0006	0.36	95,000
October, .	360,000	55	55	12	Decided.	.27	.0842	.0821	10.75	3.71	.0007	0.45	234,000
November,	288,000	51	49	12	Decided	.37	.6100	.1600	10.21	2.07	.0018	0.88	374,500
December,	362,200	47	43	9	Decided.	.40	.6012	.1084	9.09	2.72	.0016	0.72	58,800
Average,	343,800	58	55	11	Decided	.33	.1825	0844	9.44	3.20	.0100	0.57	157,600

Sewage applied, 1½ gallons seventy-two times a week, except from November 17 to 22, when filter was allowed to rest. Filter was aspirated sixteen hours each night, except during period of rest, when aspirator was run continuously. March 1 to 10 and April 18 to 20, experiment interrupted by freshet. Surface raked 3 inches deep once each week. March 10, 6 inches of gravel removed, washed and replaced. Surface spaded over 6 inches deep on June 27 and November 17.

Filter No. 22 A.

This filter contained 60 inches of fine coke breeze above the usual gravel underdrains and was constructed March 19, 1894. From that date until November, 1894, it received sewage at the rate of 240,000 gallons per acre daily, and from then until March, 1896, the average rate of filtration, excluding periods of rest, was 360,000 gallons per acre daily. During the freshet of the Merrimack River

at this latter date the filter was destroyed. During its period of operation the filter almost invariably gave an effluent containing considerable free ammonia but low in organic matter. The object of the experiment was to operate the filter at as high a rate as possible and obtain a satisfactory effluent, and remove clogged coke from the surface of the filter whenever necessary for the satisfactory working of the filter. During the experiment coke equivalent to 13.8 cubic yards per million gallons of sewage filtered was removed and when dried could be used as a fuel.

Effluent of Filter No. 22 A.

[Parts per 100,000.]

Month.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	360,000	48	41	26m.	Decided.	.38	1.5000	.0995	8.82	0.90	.0070	0.57	228,000
February, .	360,000	47	42	28m.	Decided.	.41	0.9875	.0925	5.96	1.39	.0078	1.66	100,300
Average,	360,000	48	42	27m.	Decided.	.40	1.2436	.0960	7.39	1.15	.0074	1.12	164,150

Sewage applied, 6 gallons eighteen times a week, January 1 to February 29. Surface raked 3 inches deep once a week. Six inches of coke removed from filter on January 15.

Yearly Average of Effluent of Filter No. 22 A.

[Parts per 100,000.]

Year.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
1894, . .	260,800	56	56	48m.	V. slight.	.12	1.0136	.0351	10.03	1.13	.0159	1.00	25,700
1895, . .	336,500	59	55	22m.	Decided.	.35	1.1240	.0936	11.77	1.46	.0186	0.50	176,000
1896, . .	360,000	48	42	27m.	Decided.	.40	1.2436	.0960	7.39	1.15	.0074	1.12	164,150

Filter No. 59.

This filter was one ten-thousandth of an acre in area and contained over the usual underdrains 60 inches in depth of gravel stones of an effective size of 2.50 millimeters. Down through the middle

of the filter an iron pipe 1 inch in diameter was passed and this pipe reached to within 6 inches of the bottom of the filter. By means of this pipe and an aspirator, air was drawn through the filter. The filter was put in operation April 1, 1895, and sewage was applied to it at the rate of 500,000 gallons per acre daily up to Feb. 11, 1896. The results for 1895 are given in the report for that year. Upon February 11, wool-scouring liquor was mixed with the Lawrence sewage in such proportion that one-fifth the volume of the dose applied was wool liquor. The rate of filtration and the proportion of wool liquor in the sewage applied was reduced from time to time and the filter aerated for eight hours each night, but the effluent of the filter became of a very poor quality, the wool liquor passing through practically without change, and nitrification, which was active in the filter when this liquor was first applied, was entirely destroyed.

The following table shows the rate of filtration and the average analyses and the notes below give the details of operation: —

Effluent of Filter No. 59.

[Parts per 100,000.]

1896.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consu[redacted]	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	540,000	48	43	None.	Great.	.47	0.5625	0.2530	7.96	2.01	.0086	1.24	265,000
February, .	475,200	47	46	3m.	Great.	.57	1.0088	2.0273	7.45	1.21	.0093	6.72	509,000
March, .	100,400	46	42	None.	Great.	*	1.3570	3.0200	–	0.60	.0047	19.87	2,044,000
April, .	145,400	52	46	None.	Great.	*	1.8000	1.9267	–	0.00	.0010	16.60	719,000
May, . .	145,000	63	55	None.	Great.	*	6.2500	4.1500	–	0.00	.0000	33.70	2,706,000
Average,	281,200	51	47	1m.	Great	.52	2.2766	2.2754	7.71	–	.0047	16.43	1,261,000

* Brown.

Sewage applied, 54 gallons daily, six days a week, January 1 to February 10; sewage applied in the following manner: six doses of 5 gallons each applied in the forenoon, and six doses of 4 gallons each in the afternoon. February 11 to 13, 1 gallon of wool-scouring liquor and 4 gallons of sewage applied as one of the forenoon doses; February 14 to 23, 1 gallon of wool-scouring liquor in four doses of ¼ gallon each applied with regular sewage; February 24 to March 10, dose reduced to 25 gallons of sewage and 2 gallons of wool scouring liquor, applied in nine doses of 3 gallons each; March 11 to May 16, dose reduced to 12½ gallons of regular sewage and 2 gallons of wool-scouring liquor, applied in nine doses. Filter aspirated eight hours each night March 1 to 10, experiment interrupted by freshet. March 10, the top 6 inches of gravel removed, washed and replaced. Surface raked 3 inches deep once each week.

Filter No. 65.

This filter contains, over the usual gravel underdrains, 60 inches in depth of coke breeze, and was put in operation Jan. 4, 1896. The sewage applied is that which has just been strained through a shallow layer of coke breeze (see page 479), and the average rate of filtration for the year has been 290,000 gallons per acre daily. The filter has disposed of the applied sewage easily and its effluent has been of a satisfactory quality.

The following table shows the average analyses of the effluent and the notes below give the details of operation of the filter: —

Effluent of Filter No. 65.

[Parts per 100,000.]

1896.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F — Sewage.	Temperature. Deg. F — Effluent.	Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance. — Turbidity.	Appearance. — Color.	Ammonia. — Free.	Ammonia. — Albuminoid.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	300,000	49	49	24m.	V. slight.	.06	0.7225	.0290	9.86	1.21	.0280	.15	1,667
February,	288,000	49	48	9m.	V. slight.	.06	0.0995	.0260	6.63	2.04	.0215	.18	2,010
March,	207,700	46	43	38m.	V. slight.	.06	0.2800	.0220	5.93	0.72	.0100	.08	1,470
April,	288,500	56	54	40m.	Slight.	.12	0.8433	.0527	9.10	2.20	.1167	.24	15,667
May,	292,300	66	62	40m.	Decided.	.18	2.1200	.0687	15.60	2.95	.0938	.35	29,333
June,	311,500	71	64	9m.	Slight.	.07	0.0318	.0311	10.13	2.40	.0048	.09	38,000
July,	288,900	77	71	5m.	None.	[illegible]	0.0361	.0287	15.06	2.38	.0048	.08	9,700
August,	300,000	77	73	5m.	None.	.04	0.0182	.0170	13.75	2.62	.0012	.10	2,510
September,	300,000	66	65	5m.	V. slight.	[illegible]	0.0162	.0202	12.87	1.79	.0005	.09	12,100
October,	300,000	56	51	5m.	V. slight.	.07	0.2020	.0320	11.53	3.10	.0009	.12	7,900
November,	300,000	54	53	8m.	Slight.	.06	0.3900	.0450	9.80	3.91	.0038	.16	2,100
December.	300,000	49	47	5m.	Slight.	.16	0.7125	.0690	10.78	3.54	.0042	.28	3,050
Average,	299,700	60	56	16m.	V. slight.	.09	0.5149	.0380	10.74	2.49	.0242	.15	11,137

Five gallons of sewage strained through coke applied eighteen times a week. March 1 to 10, experiment interrupted by freshet. Surface raked 3 inches deep once each week, January 1 to May 26, and twice each week, May 26 to December 31. Surface dug over 6 inches deep on May 21.

Filters Nos. 66 and 67.

Filter No. 66 is one three-thousandth of an acre in area and contains 60 inches in depth of gravel of an effective size of 5.10 millimeters. The filter has a wooden bottom perforated with many holes, to allow the escape of the effluent freely without collection and passage through a single outlet, as is the case with the other filters. At the beginning of the experiment the two filters were connected by an air-tight chamber and the effluent of Filter No. 66 passed directly upon the surface of Filter No. 67, placed below Filter No. 66.

Filter No. 67 is of one-half the area of Filter No. 66 and contains 60 inches in depth of sand of an effective size of 0.19 millimeter. A pressure pump capable, at its ordinary rate of operation, of pumping nineteen gallons of air per minute, was connected with the air-tight chamber, and the air delivered into this chamber was forced up through the entire body of filtering material in Filter No. 66. This filter has been operated at rates varying from 90,000 to 513,000 gallons per acre daily, and with the amount of aeration given, as shown by the notes beyond, nitrification has been kept active. Owing, however, to the perforated bottom of the filter a considerable percentage of the sewage sludge has passed down through the filter instead of being stored within the filter.

Filter No. 67 has received, during a large portion of the year, the entire effluent of Filter No. 66, and has given a satisfactory effluent. This high rate of filtration has been maintained with considerable difficulty, owing to the amount of sludge in the effluent of Filter No. 66, and the clogged sand removed from Filter No. 67 has amounted to 22 cubic yards per million gallons of sewage filtered.

On November 7 the surface of Filter No. 66, with the exception of a circular opening 8 inches in diameter in the centre, was covered with 6 inches of coke breeze. The coke was for the purpose of straining out some of the sludge of the sewage, and the opening to allow the circulation of air when the filter was being aerated. The quality of the effluent was slightly improved by this change, but not enough to expect that the high rate of filtration through Filter No. 67 can be maintained without large removals of clogged sand from time to time or prolonged periods of resting.

The electric power to operate the aerating apparatus has been obtained from the Lawrence Gas Company, and, for the amount of

aeration given, the cost has been at the rate of several hundred dollars per million gallons of sewage filtered. With a larger plant, the cost would be less in proportion to the sewage filtered, but it seems improbable that it would be reduced sufficiently to be considered reasonable in sewage purification.

Effluent of Filter No. 66.

[Parts per 100,000.]

1896.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature, Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
								Albuminoid.							
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
Mar.,	99,400	47	57	None.	Decided.	.43	0.6000	.1133	.0887	.0246	7.10	1.14	.0178	0.92	316,000
Apr.,	377,300	50	58	1m.	Decided.	.82	1.3929	.2357	2357	.0600	9.01	1.60	.0443	1.51	829,000
May,	432,700	50	62	12m	Decided.	[redacted]	1.0700	.2540	.2080	.0460	15.71	2.66	.0438	1.31	1,272,000
June,	203,200	64	68	None.	Great.	.75	1.0187	.3733	.2033	.1700	10.67	3.31	.0120	3.38	871,000
July,	431,300	70	74	None.	Great.	.72	1.6000	.5980	.1904	.4076	16.17	1.08	.1640	4.66	[redacted]
Aug.,	450,000	72	75	None.	Great.	.61	1.6667	.7200	.1800	.5400	13.70	2.18	.0290	5.00	1,883,000
Sept.,	264,400	63	65	None.	Decided.	.46	1.0800	.3600	.1846	.1754	10.91	3.19	.0125	2.69	1,042,000
Oct.,	296,100	54	53	None.	Decided.	.45	1.1400	.2680	.1627	.1053	10.74	2.11	.0130	1.36	476,000
Nov.,	460,000	46	53	3m.	Decided	.63	2.2700	.3300	.2380	.0920	7.76	1.52	.0128	1.30	928,000
Dec.,	513,300	49	54	4m.	Decided	.57	2.0300	.3255	.2050	.1205	6.19	2.36	.0093	1.30	340,000
Av.,	351,300	58	62	2m.	Decided	.62	1.1972	.3623	.1896	.1731	10.60	2.29	.0348	2.49	989,500

Sewage applied, 5 gallons thirty times a week, March 10 to 22, 10 gallons thirty times a week, March 23 to 29; 20 gallons thirty times a week, March 30 to April 12; April 13 to June 8, 150 gallons daily, applied in five doses of 20 gallons each and two doses of 25 gallons each; June 9 to 14, 30 gallons thirty times a week, June 15 to 21, 25 gallons thirty times a week, June 22 to 28, 15 gallons thirty times a week; June 29 to September 6, 150 gallons daily, applied in five doses of 20 gallons each and two doses of 25 gallons each, September 7 to October 5, 75 gallons daily, applied in six doses of 10 gallons each and one dose of 15 gallons; October 6 to November 10, 11 gallons sixty times a week; November 11 to December 31, 20 gallons sixty times a week; April 3 to 12, filter aerated one half hour eighteen times a week; April 13 to June 8, one-half hour twenty-four times a week; June 9 to 14, one-half hour thirty-six times a week; June 15 to 21, one half hour twenty-four times a week; June 22 to 28, one-half hour thirty times a week; June 29 to July 21, fifteen minutes forty-two times a week, July 22 to September 6, thirty minutes forty-two times a week, September 7 to October 5, fifteen minutes twelve times a week; October 6 to 14, fifteen minutes thirty-six times a week; October 15 to 25, thirty minutes forty-two times a week, October 26 to November 8, forty-five minutes forty-two times a week; November 9 to December 31, fifteen minutes sixty times a week. April 3 to May 3, door between 66 and 67 left open during the night; May 4 to 26, door closed all the time; May 27 to June 7, door left open during the night; June 8 to December 31, door left open all the time except while filter was being aerated. May 18 to October 5, surface raked 3 inches twice a week; October 6 to November 19, surface not raked; November 20 to December 31, raked 1 inch daily. June 27, filters 66 and 67 disconnected. November 7, surface raked 3 inches deep, and surface covered with 6 inches of coke, except a circular hole 9 inches in diameter in the centre of tank. November 16, 1 inch of coke removed.

Effluent of Filter No. 67.

[Parts per 100,000.]

1896.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
March, .	178,800	57	54	None.	V. slight.	.11	0.3967	.0227	7.02	1.32	.0245	.20	16,400
April, .	754,800	53	53	None.	None.	.14	0.4514	.0371	9.32	2.57	.1074	.34	1,095
May, . .	865,400	62	63	None.	None.	.29	0.2100	.0764	15.70	3.46	.1980	.63	81,974
June, . .	892,000	66	67	None.	Decided.	.54	1.1435	.1287	11.50	2.57	.1400	.65	196,000
July, . .	522,200	74	74	None.	V. slight.	.27	0.0223	.0362	27.59	2.86	.0164	.29	[illegible]
August, .	385,500	75	74	None.	V. slight.	[illegible]	0.0186	.0305	13.86	2.65	.0116	.35	31,350
September,	484,600	65	64	None.	V. slight.	.21	0.0378	.0329	12.41	4.14	.0056	.32	4,900
October, .	477,800	53	51	None.	V. slight.	.28	0.0947	.0420	10.70	3.36	.0021	[illegible]	21,000
November,	613,800	53	52	None.	V. slight.	.40	0.1993	.0650	11.62	2.72	.0177	.63	25,000
December,	1,011,000	54	51	None.	Slight.	.40	0.5775	.0650	9.38	3.76	.0075	[illegible]	33,460
Average,	606,500	63	60	None.	V. slight.	.28	0.3181	.0560	12.90	2.74	.0521	.46	40,785

Effluent of Filter No. 66 applied · March 10 to June 30, all the effluent; July 1 to 12, one-half of the effluent in three doses of 25 gallons each; July 13 to 28, four doses of 25 gallons each; July 29 to September 6, four doses of 31½ gallons each; September 7 to October 5, four doses of 18¾ gallons each; October 6 to November 10, four doses of 27½ gallons each; November 11 to December 31, four doses of 50 gallons each. March 31 to April 17, surface raked 3 inches deep twice a week; April 18 to December 31, raked 3 inches deep daily. Surface dug over to a depth of 6 inches on the following dates: April 17; June 4, 6, 8, 11, 22, 29, July 1, 17; September 2; October 3, 10, 15, 19, 23, 26, 30; November 9, 12, 14, 16, 17, 23, 24, 25. June 27, filters 66 and 67 disconnected, and from 4 to 5 inches of sand removed from surface. November 26, 6 inches of sand removed.

Filters Nos. 80 and 81.

Filter No. 80 contains 4.5 feet in depth of coal ashes and has received sewage at the rate of 70,000 gallons per acre daily. Its effluent has been bright and clear from the beginning and in January of the present year (1897) nitrification began to be active.

Filter No. 81 contains 4.5 feet in depth of cinders and has received sewage which had first been strained through coke breeze at the rate of 550,000 gallons per acre daily. The method of operating the filter has been as follows: In the morning the outlet is closed and sewage is applied in hourly doses until the surface is covered; the filter is allowed to remain in this condition for two hours, when the outlet is opened and the filter slowly drained.

Effluent of Filter No. 80.

[Parts per 100,000.]

Date — 1896.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
November, .	73,200	47	54	V. slight.	.07	3.8400	.0380	12.17	.016	.0012	.26	2,310,000
December, .	61,000	45	49	V. slight.	.19	4.4200	.1124	11.21	.086	.0444	.32	33,400
Average, .	67,100	46	52	V. slight.	.13	4.1300	.0752	11.69	.051	.0228	.29	1,171,700

Effluent of Filter No. 81.

[Parts per 100,000.]

Date — 1896.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
November, .	610,000	54	54	Decided.	.58	4.70	.25	7.20	.151	.0140	1.02	-
December, .	514,200	49	49	Decided.	.60	4.21	.29	[illegible]	.064	.0049	1.06	606,400
Average, .	562,100	52	52	Decided.	.59	4.46	.27	5.70	.108	.0095	1.04	606,400

FILTRATION OF WATER.*

Seven of the experimental filters, used for the purpose of studying the purification of water by sand filtration during 1895 and previous years, have been continued in operation during 1896, and the results obtained by these filters, together with those obtained by three additional filters and the large filter 2.5 acres in area, constructed by the city of Lawrence and put in operation Sept. 20, 1893, are presented in the following pages. Reports of the Board for previous years have given facts and figures regarding the filtration of Merrimack River water through various depths and kinds and grades of sand, at various rates of filtration and with both continuous and intermittent filters. The data obtained and recorded in those reports are here added to, together with such new observations as seem to be especially worth recording.

Two distinctly new lines of investigation have been started: one, the study of the sand filtration of water much more polluted, both chemically and bacterially, than the Merrimack River water, and the other, studies in regard to the removal of iron in such forms as it exists in some of the water supplies of the State. The study of the purification of a highly polluted water has been carried on during a large portion of the year and considerable data can be given, but the study of the removal of iron was begun during the last part of the year.

The table on the following page shows the rate of filtration and the bacterial efficiency for the year of those filters receiving Merrimack River water. Determinations of the number of bacteria in the water applied to the filters are made twice each day, determinations of the bacteria in the effluents of filters Nos. 3 B, 7 A and 8 A four times each day, and of the smaller filters always once and sometimes twice each day.

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* In preparing this paper the writer has had the assistance of Mr. W. R. Copeland.

Summary of Average Daily Bacterial Results obtained from the Experimental Filtration of Merrimack River Water.

Number of Filter.	Date of Construction.	Effective Size of Sand (Millimeter.)	Uniformity Coefficient.	Depth of Material. (Inches.)	Method of Operation.	Average Rate of Filtration. — Gallons per Acre Daily.	Average Number of Bacteria per Cubic Centimeter. Applied Water.	Average Number of Bacteria per Cubic Centimeter. Effluent.	Average Per Cent. which the Number of Bacteria in the Effluent was of the Number of Bacteria in Applied Water.	Average Bacterial Efficiency.
3 B, ...	Sept. 23, 1893,	0.23	2.3	52	Intermittent, .	2,868,000	8,900	41	0.46	99.54
7 A, ...	July 20, 1894,	0.26	3.7	18	Continuous, .	4,124,000	8,700	66	0.76	99.24
8 A, ...	Sept. 26, 1893,	0.23	2.3	53	Continuous, .	3,694,000	8,900	27	0.30	99.70
18 A, ...	Sept. 17, 1889,	0.48	2.4	60	Intermittent, .	4,740,000	10,200	47	0.46	99.54
33 A, ...	April 28, 1892,	0.14	2.2	50	Continuous, .	1,960,000	10,200	73	0.72	99.28
48, ...	May 20, 1893,	0.26	3.7	32	Continuous, .	4,880,000	10,900	81	0.74	99.26
62, ...	Sept. 2, 1895,	0.40	1.9	39	Continuous, .	4,880,000	10,200	77	0.75	99.25
63, ...	Sept. 2, 1895,	0.16	2.3	24	Continuous, .	3,040,000	10,200	61	0.60	99.40
64, ...	Sept. 2, 1895,	0.16	2.3	6	Continuous, .	3,000,000	10,200	480	4.70	95.30

Discussion of Bacterial Efficiency of the Filters.

By a study of the table it is seen that all of the filters having an average depth of more than 12 inches of sand maintained an average bacterial efficiency of 99.24 per cent. or more. The greatest average efficiency, 99.70 per cent., was obtained by the large filter, No. 8 A, one two-hundredth of an acre in area, situated out of doors, containing 52 inches in depth of sand and operated continuously. Filter No. 3 B, of the same area and depth and also out of doors, but operated intermittently, gave an average bacterial efficiency of 99.54 per cent., but its average rate of filtration was much less than that of Filter No. 8 A. An examination of the tables of daily results (see page 537 and following) shows that these large filters maintained a more uniform efficiency than the small filters, and that, of the large filters, the most uniform results were obtained by Filter No. 8 A. Nearly as uniform results were obtained by Filter No. 3 B, and both filters gave a decidedly better day-by-day efficiency than the shallower or smaller filters.

Rates of Filtration and Bacterial Efficiency.

Filters Nos. 3 B to 64, inclusive, have been operated at rates of filtration, in gallons per acre daily, varying from 1,960,000 on the part of Filter No. 33 A to 4,880,000 on the part of filters Nos. 43 and 62, and at these rates the bacterial efficiency obtained has been satisfactory. The efficiency has not borne a direct relation to the rate of filtration nor to the degree of coarseness or fineness of the sand. Filter No. 18 A, containing sand of an effective size of 0.48 millimeter and operating at the rate of 4,740,000 gallons per acre daily, has given an effluent containing on an average 47 bacteria per cubic centimeter, and Filter No. 33 A, containing sand of an effective size of 0.14 millimeter and operating at a rate of 1,960,000 gallons per acre daily, has given an effluent containing on an average 73 bacteria per cubic centimeter. It is true that Filter No. 18 A contained a greater depth of sand and that there was at times a growth of bacteria within the sand of Filter No. 33 A, as will be explained later, but the fact remains that the coarsest filter operating at the highest rate gave the best result. On the other hand, Filter No. 33 A could undoubtedly have been operated at a higher rate than

it was operated and have given as good an effluent, while the rate of Filter No. 18 A if increased materially would probably have caused poor results to follow. Filter No. 33 A might even have given a better result at a higher rate, from the fact that the more rapid passage of the water through the filter would perhaps have diminished the number of those bacteria in the effluent which grew within the filter. (See page 525.)

The advantage of a filter of fine sand, such as Filter No. 33 A, over a filter of coarse sand is most marked at the beginning of its period of operation. The results then obtained are much better than obtained at the outset with coarse sand, but as the period of service of filters increases the efficiency of the coarse sand filters increases and the volume of water passed between scrapings is greater, other things being equal, with a filter of coarse sand. Better results immediately after scraping are, with the same treatment in each case, obtained by a filter of comparatively fine sand. These facts have been repeatedly stated in different reports of the Board, and tables given illustrative of them, and their repetition here is simply by way of explanation of the table given.

Remarks in Regard to Shallow and Deep Filters.

As noted in earlier reports of the Board, disturbing influences, such as scraping, fluctuations of rate of filtration, etc., affect more seriously the bacterial results obtained from shallow than from deep filters. It has also been noted that depth of water over the surface of a sand filter exerts a pressure upon the surface, rendering the upper sand layers so compact that the maximum rate, or quantitative capacity of the sand to the flow of water, is reduced. (See page 706, report of 1894.) Owing to this fact of pressure, of two filters containing the same total depth of sand and water, other things being equal, that one containing the greatest depth of sand and thus the least depth of water over its surface will require less frequent scraping than the one in which the relative depth of sand and water is reversed. It is also true that with the same depths of water over the surface of two filters containing different depths of sand the one containing the greatest depth of sand will require the least scraping. Filters Nos. 63 and 64, both filtering river water at a rate of 3,000,000 gallons per acre daily, and containing, from May 8 to July

28, an average depth of 22 and 9 inches of the same grade of sand respectively, have given results upon this point shown in the following table: —

Number of Scrapings, Water filtered between Scrapings, etc., with a Shallow as compared with a Deeper Filter.

Number of Filter.	Depth of Sand in Inches.	Average Depth of Water on Surface.	Number of Scrapings.	Number of Gallons filtered between Scrapings (per Acre).	Average Rate of Filtration (Gallons per Acre Daily).
64, ...	9	10	15	15,900,000	2,900,000
63, ...	22	10	12	20,560,000	3,000,000

On July 28 the head on Filter No. 64 was reduced so that the depth of water on the surface compared to the depth of sand should correspond more nearly with the ratio of the depth of water to depth of sand in Filter No. 63.

The results obtained from filters Nos. 63 and 64, covering the period May 18 to October 31, together with results from the larger filters, Nos. 7 A and 8 A, have been gathered together in the following table. Filter No. 7 A had not been in operation for the four months just previous to this period and its surface was therefore very porous, but as Filter No. 8 A had been scraped and dug over 6 inches deep on April 11, the surface layers of 7 A and 8 A were probably about equally porous when the experiment started.

Table showing the Number of Scrapings, Cubic Yards of Sand removed, etc., in operating Shallow as compared with Deeper Filters.

Number of Filter.	Period.	Average Depth of Sand (Inches).	Number of Scrapings.	Actual Number of Gallons filtered.	Cubic Yards of Sand removed per Million Gallons filtered.	Average Bacterial Efficiency.
7 A, ...	Apr. 13 to Dec. 31,	13	14	4,825,165	0.98	99.25
8 A, ...	Apr. 13 to Dec. 31,	48	11	5,214,181	0.67	99.71
64, ...	May 18 to Oct. 31,	7	29	24,210*	-	98.16
63, ...	May 18 to Oct. 31,	21	21	24,607*	-	99.41

* Filters Nos. 63 and 64 are only one-hundredth the area of filters Nos. 7 A and 8 A.

From this table it is evident that the shallow filters Nos. 7 A and 64 were scraped more frequently, that the number of cubic yards of

sand scraped off per million gallons of water filtered was greater, and that the average bacterial efficiency was less than of the deeper filters Nos. 8 A and 63. The table is significant owing to the fact that one of the largest items in the cost of running sand filters is caused by scraping sand from the filter and replacing it with new.

Effect of Spading the Surface Layers of Deep and Shallow Filters.

It has been stated in the present report, and considerable data upon the subject have been given in previous reports, that shallow filters are much more sensitive to disturbing influences than deeper ones. That is to say, when the surface deposit is removed or the surface spaded over, that a filter containing a considerable depth of sand will produce a better bacterial efficiency immediately afterwards than one containing a shallower depth of sand.

The two following tables illustrate this point: —

Effect produced upon Bacterial Efficiency by Spading a Shallow Filter.

[Bacteria per Cubic Centimeter in the Effluent from Filter No. 7 A.]

DATE — 1897.	Hour.	Bacteria.	Remarks. (Filter 15 Inches Deep.)
January 16,	5.00 A.M.	25	Before spading.
18,	8.45 A.M.	140	Outlet gate just opened.
18,	9.00 A.M.	825	
18,	9.10 A.M.	2,506	
18,	11.00 A.M.	2,262	
18,	2.00 P.M.	3,024	
18,	5.00 P.M.	3,144	
19,	-	2,174	Average of three analyses.
20,	-	1,806	Average of three analyses.
21,	-	2,099	Average of three analyses.
22,	-	1,297	Average of three analyses.
23,	-	1,176	Average of three analyses.
25,	-	536	Average of three analyses.
26,	-	173	Average of three analyses.
27,	-	107	Average of three analyses.

NOTE. — The number of bacteria in the canal water applied to Filter No. 7 A on January 18 averaged 12,900 per cubic centimeter.

Effect upon Bacterial Efficiency produced by Spading a Deep Filter.

[Bacteria per Cubic Centimeter in the Effluent from Filter No. 8 A.]

Date — 1896.	Hour.	Bacteria.	Remarks. (Filter 45 Inches Deep.)
December 1,	5.00 A.M.	19	Before spading.
3,	9.00 A.M.	6	Outlet gate just opened.
3,	10.15 A.M.	8	
3,	11.30 A.M.	9	
3,	1.30 P.M.	9	
3,	3.00 P.M.	14	
3,	5.00 P.M.	6	
4,	-	54	Average of three analyses.
5,	-	125	Average of three analyses.
7,	-	413	Average of three analyses.
8,	-	328	Average of three analyses.
9,	-	294	Average of three analyses.
10,	-	158	Average of three analyses.
11,	-	97	Average of three analyses.
12,	-	73	Average of three analyses.

Note. — The number of bacteria in the canal water applied to Filter No. 8 A on December 3 averaged 4,800 per cubic centimeter.

Both of these filters were spaded over 6 inches deep and after spading were filled slowly with city water from below and allowed to stand for twenty-four hours. On the days when the outlet valves were again opened Filter No. 7 A ran at a rate of 5,034,000 gallons per acre daily, but Filter No. 8 A fell a little short of this, running at a rate of 4,390,000 gallons. This rate gradually increased until it reached 5,000,000 gallons, and maintained an average rate of 5,180,000 gallons per acre daily from December 5 to 10.

The difference in rate between 4,300,000 and 5,000,000 gallons per acre daily was not sufficient to account for the great difference between the numbers of bacteria which were found in the effluents of filters Nos. 8 A and 7 A on the first day after the outlets were opened. For instance, the number of bacteria found in the effluent from Filter No. 8 A averaged 9 per cubic centimeter, whereas the number found in the effluent from Filter No. 7 A averaged 1,984 per cubic centimeter. The mechanical disturbance of spading affected Filter No. 8 A to some extent however, and the bacterial efficiency

decreased together with the increase in rate during the period from December 4 to 10. Thus the figures given in the table show that, whereas on December 3 the bacteria in the effluent of Filter No. 8 A averaged 9 per cubic centimeter, during the period from December 4 to 10 the bacteria averaged 274 per cubic centimeter.

Remarks in Regard to Intermittent and Continuous Filtration.

For six years filters receiving Merrimack River water and operated continuously and intermittently have been studied at this station. The first experimental water filter, No. 8, was put into operation in November, 1887, and continued until September, 1893. This filter contained, above the usual underdrains, 3 feet and 8 inches in depth of a mixture of gravel and sand of an effective size of 0.35 millimeter; above this layer were 8 inches of yellow loam, and above this a layer 6 inches deep of the same kind of material as that which lay below the loam.

City water was applied to this filter at rates varying from 100,000 to 300,000 gallons per acre daily, and the effluent was a clear, bright, almost colorless water with a taste like that of spring water. On Nov. 13, 1891, Merrimack River water, taken from the Essex Company's canal, began to be applied to this filter at the rate of 300,000 gallons per acre daily, instead of the city water previously applied. The river water contained many times as many bacteria per cubic centimeter and more organic matter than the city water previously applied, which, although taken from the river in the first place, had passed through the reservoir and city service pipes before reaching the station. The effluent of the filter, however, continued as pure chemically and with no more bacteria than when city water was applied. The average removal was 99.97 per cent. and the few bacteria appearing in the effluent were believed to be due to growths in the underdrains.

Thus the effluent of this filter was in every way satisfactory, but owing to the layer of loam it was impossible to increase the rate of filtration above 300,000 gallons per acre daily; and, as this loam began to clog with the organic matter removed from the water, this quantitative capacity decreased and the filter was discontinued in 1893, as before stated.

In the meantime other filters were put in operation, some of sand with layers of loam and others with their entire depth above the

underdrains consisting of one grade of sand, and at the close of 1892, eighteen water filters either were or had been in operation at the station, ten continuous and eight intermittent filters, and in the report for that year a comparison of results obtained by the two methods of filtration was given and the statements made that: —

1. In continuous and intermittent filtration through materials of the sizes employed and at the given rates there is no very great difference in the amount of organic matter removed from the applied water.

2. Continuous filters require scraping less frequently than intermittent.

3. It will be necessary to obtain more data before making definite conclusions in regard to the bacterial efficiency of the two methods.

During this year the rates of filtration of the different filters varied from a few hundred thousand to two million gallons per acre daily. During 1893 the number of experimental filters was added to and the rates of filtration in gallons per acre daily increased, so that several filters were operated at the rate of between three and five million gallons per acre daily and the comparative results obtained from the continuous and intermittent filters were summarized as follows: —

1. That in the case of the filters of fine sand, in which there is a saturated layer of considerable depth, the bacterial efficiency was substantially the same by each method employed in the application of water during the greater part of the year, but during midsummer (July 24 to September 2) the continuous filters allowed a few more of the hardy water bacteria, but not of *B. prodigiosus*, to pass through.

2. That with filters of coarser sands, operated at comparatively high rates, the continuous filters are ordinarily more efficient in removing bacteria than the intermittent filters under the existing methods of operation. The reason of this is that the actual rate of flow was lower and more uniform and there was no mechanical disturbance of the sand, as was the case during the greater part of the period with the intermittent filters, owing to the manner of filling and driving out the air.

During 1894, 1895 and 1896 intermittent and continuous filters were continued in operation, and the results obtained from all of them have been important and instructive, but the most important

have undoubtedly been obtained by filters Nos. 3 B and 8 A. These two filters were put in operation in September, 1893, and from the day when first flooded up to the present time have been running without interruptions, except those caused by scraping or other necessary details of operation. These two filters are each one two-hundredth of an acre in area and their location is such as to make them comparable with large filters of a city supply system. They each have the same depth of the same grade of sand and have been operated at rates varying from 2,000,000 to 5,000,000 gallons per acre daily. Filter No. 3 B has always been operated intermittently while Filter No. 8 A has been operated continuously, and the following table gives the average rate of filtration and the average bacterial efficiency of each filter for each year of operation: —

Filter Number.	Year.	Rate.	Bacterial Efficiency.
3 B,	1893,*	2,095,000	95.60
8 A,	1893,*	1,903,000	97.80
3 B,	1894,	2,932,000	99.16
8 A,	1894,	3,107,000	99.22
3 B,	1895,	3,096,000	99.16
8 A,	1895,	3,576,000	99.73
3 B,	1896,	2,868,000	99.54
8 A,	1896,	3,694,000	99.70

* Three months only.

The table shows that Filter No. 8 A has been operated at a higher rate of filtration than Filter No. 3 B, although it can be stated here that it has been the intention to have the two filters operating at equal rates. (The explanation of the difference in rate of flow is given on page 516 and following.) The table also shows that the bacterial efficiency of Filter No. 8 A has always averaged greater than that of Filter No. 3 B, and it can be stated here, and an examination of the tables of daily results given in the various reports will show, that its uniform efficiency has also been greater.

The reason that continuous filtration has been so entirely successful is the fact that the river water always contains dissolved oxygen in such quantities that the effluents of the continuous filters always

contain it, except in midsummer, when with filters of fine sand its entire or almost entire absence has been noted on several occasions. The effluents of filters constructed of sand as coarse as that of filters Nos. 3 B and 8 A have never shown an entire absence of oxygen.

Filters Nos. 3 B and 8 A, one two-hundredth of an Acre in Area.

Comparison of Quantitative Efficiency in Gallons per Acre Daily, the Average Number of Gallons filtered between Scrapings, and the Per Cent. of Bacteria removed in Winter Weather, Dec. 1, 1896, to Feb. 27, 1897.

Number of Filter.	Average Temperature of Effluent (Degrees F.).	Number of Scrapings.	Whole Number of Gallons filtered during this Period.	Average Rate (Gallons per Acre Daily).	Average Number of Gallons filtered between Scrapings (per Acre of Filter surface).	Average Number of Bacteria per Cubic Centimeter in the Applied Canal Water.	Average Number of Bacteria per Cubic Centimeter in the Effluent.	Average Per Cent. of Bacteria removed.
3 B, ...	35	6	1,406,291	3,142,600	46,876,400	9,400	133	98.59
8 A, ...	35	5	1,608,064	3,582,200	64,122,800	9,400	75	99.17

The Quantitative Capacity of the Intermittent and Continuous Filters Nos. 3 B and 8 A.

The table on page 507 shows that the average rates of filtration for filters Nos. 3 B and 8 A were, respectively, 2,868,000 and 3,964,000 gallons per acre daily. The whole number of gallons filtered during the year was 4,645,440 gallons for 3 B and 5,984,107 for 8 A, or 3 B filtered 1,339,000 gallons less than 8 A, although the intention was to have the same number of gallons pass through each filter every day. To do this, of course, the rate of filtration of 3 B would necessarily be greater, during a portion of the day, than the rate of 8 A, in order to make up for that period of the day when the surface of 3 B was uncovered and the filter simply draining. It was impossible, however, with Filter No. 8 A operating at the rate given, to equalize the flow for the following reason: the surface of 3 B stands uncovered for two hours each day and, as the water gradually sinks away from the surface, air presses in to fill up the interstices between the grains of sand. When water is again turned on to the filter the air held in the sand works its way to the surface, or is forced downward and out through the underdrains. The applied water carries considerable fine material in suspension, and this is strained out at the surface and in the open spaces in the upper layers

of sand so that the channels by which the air can escape easily are soon filled. No longer having an easy chance of escape, the air which is retained in the filter fills up the open spaces and increases the frictional resistance to the passage of water through the sand. Since the water works its way more slowly each day through the filter, owing to increased clogging, it takes a longer time each day for the intermittent filter to uncover and also for it to return to its maximum rate of flow. The more slowly the rate increases, the smaller the amount of water filtered will be each succeeding twenty-four hours. Owing largely to the presence of air in the filter, therefore, the quantity of water filtered through 3 B has been less than through 8 A.

Comparison of the Quantitative Efficiency of Intermittent and Continuous Filters, 3 B and 8 A, at Different Seasons of the Year.

Season of the Year.	3 B (Intermittent).			8 A (Continuous).		
	Average Temperature of Effluent (Degrees F.).	Average Number of Days elapsed between Scrapings.	Average Number of Gallons passed between Scrapings (per Acre Daily).	Average Temperature of Effluent (Degrees F.).	Average Number of Days elapsed between Scrapings.	Average Number of Gallons passed between Scrapings (per Acre Daily).
Warm, ...	60	17	3,558,000	71	17	4,467,000
Cold, ...	43	11	3,271,000	42	25	4,623,000

The table also shows that Filter No. 8 A was scraped much oftener in summer than in winter, but this low summer average of seventeen days between scrapings was partly due to the fact that the surface of this continuous filter became covered several times during the summer with a thick mat-like growth of *spirogyra* which had to be removed. Omitting the scrapings from this cause the average number of days elapsing between scrapings would be greater.

One reason why the winter average of days elapsing between scrapings is so great is that on December 1 the filter was spaded over to the depth of 6 inches.

Air dissolved in the Water and its Physical Action in Filtration.

The canal water always contains some dissolved oxygen; the amount varies with the temperature and is greater in cold than in warm water. During summer weather the canal water is warm and contains a small amount of dissolved oxygen; but as this water

penetrates the filter it becomes colder, because the temperature within the filter is lower than that of the water or outside air and for this reason it absorbs some of the air held in the sand. Hence during warm weather the water in passing through the filter reduces the amount of air held in the sand and thus decreases the frictional resistance of the filter to the flow of water. On the other hand, during cold weather the water when applied to the filter is generally nearly or quite saturated with dissolved oxygen and gives up part of it as it passes down through the warmer bed of sand. In cold weather, therefore, while passing through the filter the water increases the amount of air held in the sand and as a result the frictional resistance of the filter to the passage of water is increased. It is also true that the viscosity of cold water is greater than that of warm water and a given amount of frictional resistance in a filter will retard the flow of water in winter more than it will in summer.

Continuous filters are affected less in this respect by the change of temperature in winter, because the surface of the filter remains covered and the air set free from the water as it passes through the filter, and held in the sand, is not added to by air introduced by surface exposure. As a result, the frictional resistance to the passage of water is less than in an intermittent filter and the period between scrapings is longer. These conclusions are of the filtration of water of about the character of that of the Merrimack River.

Removing Air from Filters by allowing them to stand with Outlets closed for Twenty-four Hours.

It has been found that, when air has accumulated in the pores of a continuous filter to such an extent that it interferes with and decreases the rate of filtration, allowing the filter to stand inoperative for twenty-four hours, with its surface covered with water, expels, absorbs or exhausts the air, and on again starting filtration the frictional resistance of the filter to the passage of water has decreased and the desired rate of filtration can be continued for a considerable period without the necessity of scraping. The following record illustrates this point.

The prescribed rate of Filter No. 8 A is 5,000,000 gallons per acre daily, and, as this filter is one two-hundredth of an acre in area, to maintain this rate it is necessary to filter 25,000 gallons of water each twenty-four hours. As before stated, an effort is made to operate Filter No. 3 B at the same rate.

Both filters were scraped on a certain day in the usual manner, the water first being drained from them sufficiently to allow the surface to be walked upon. This draining of course allowed air to enter each filter, a daily occurrence with 3 B but unusual with 8 A and occurring only at times of scraping. Both filters were then filled slowly from below with city water and allowed to stand for twenty-four hours with their surfaces covered with water. On putting both filters into operation again, Filter No. 8 A allowed only 14,738 gallons to pass through it in the first twenty-four hours of operation, although the outlet valve was wide open. This total flow increased daily owing to the absorption or expulsion of the air from the filter, until on the fourth day it was 21,004 gallons, where it remained for several days. Filter No. 3 B, on the other hand, on being put into operation after scraping, allowed 29,351 gallons of water to flow through it on the first day and this rate decreased daily until on the fourth day, with the outlet valve wide open, the total flow was only 22,000 gallons. This being the usual action of these two filters after being scraped.

After Filter No. 3 B had been in operation four days following scraping and Filter No. 8 A seven days, both filters were allowed to stand inoperative for twenty-four hours with their surfaces covered with water. Following this treatment it was possible to maintain the desired rate of flow through Filter No. 8 A for seven days. With Filter No. 3 B, however, only on the day following standing closed did the volume of effluent approximate 25,000 gallons, and on this day the filter was operating continuously.

Summarizing, it can be said that when Filter No. 8 A is scraped to remove clogging and air allowed to enter it, on again starting filtration, other things being equal, its rate of flow is low at first but increases day by day for several days. When Filter No. 3 B is treated in a like manner its rate of flow is greatest on the day following such treatment and decreases daily.

Allowing both filters to stand inoperative for twenty-four hours has a more permanent effect upon the rate of Filter No. 8 A than upon the rate of Filter No. 3 B.

Table showing the Effect of closing the Outlet of Intermittent and Continuous Filters, Nos. 3 B and 8 A, for Twenty-four Hours, at Different Seasons.

NUMBER OF FILTER.	WARM WEATHER.			COLD WEATHER.		
	Average Temperature of Effluent (Degrees F.).	AVERAGE NUMBER OF GALLONS FILTERED PER ACRE DAILY DURING THE PERIOD FROM —		Average Temperature of Effluent (Degrees F.).	AVERAGE NUMBER OF GALLONS FILTERED PER ACRE DAILY DURING THE PERIOD FROM —	
		Scraping to Standing Closed for 24 Hours.	Standing Closed for 24 Hours to the next Scraping		Scraping to Standing Closed for 24 Hours.	Standing Closed for 24 Hours to the next Scraping.
3 B, . . .	68	3,878,000	3,641,000	40	3,348,000	2,958,000
8 A, . . .	74	4,960,000	4,405,000	39	3,081,000	3,395,000

This table shows that by allowing continuous Filter No. 8 A to stand closed for twenty-four hours in cold weather, the average daily flow increased from 3,081,000 gallons per acre daily to 3,395,000 gallons per acre daily, an increase of 314,000 gallons. In warm weather, on the other hand, the average daily flow fell off from 4,960,000 gallons per acre daily to 4,405,000 gallons per acre daily, a decrease of 555,000 gallons. The reasons why the flow increased in cold weather has already been explained. Turning to the figures for intermittent Filter No. 3 B we find that the quantitative capacity fell off, in warm weather, from 3,878,000 gallons per acre daily to 3,641,000 gallons, or 6 per cent., and in cold weather from 3,348,-000 gallons per acre daily to 2,958,000 gallons, or 11 per cent. From this we may infer that standing closed produced less effect in cold than in warm weather. The reasons for this are found in the facts, as stated on page 517, that a greater quantity of air collects in the sand in cold weather, and also because the viscosity of the water is greater in cold weather. These two factors combine to increase the frictional resistance to the passage of water through the sand and reduce the quantitative capacity of the filter.

The mechanical disturbance caused by spading the surface has already been referred to in connection with the decrease in bacterial efficiency which follows scraping, and it has been shown on page 519 that the quantitative efficiency of an intermittent filter is greater than that of a continuous filter on the few days which immediately follow a scraping. It is interesting to note in this connection the average number of bacteria in the effluents of filters Nos. 3 B and 8 A on the days after a scraping in 1896.

Average Number of Bacteria in the Effluents of Filters Nos. 3 B and 8 A for the Three Days following Scraping, 1896.

Number of Filter.	Whole Number of Times scraped.	Average Number of Bacteria per Cubic Centimeter in Effluent.
3 B,	20	88
8 A,	15	27

This table shows that the number of bacteria per cubic centimeter was greater in the effluent from intermittent Filter No. 3 B than in the effluent from continuous Filter No. 8 A. We may therefore infer that scraping produced the most marked effect on the bacterial efficiency of the intermittent filter, but it must also be remembered that the rate of filtration of Filter No. 3 B has been greater immediately after scraping than the rate of Filter No. 8 A.

Average Chemical Analysis for the Year 1896 of the Effluents of Filters Nos. 3 B and 8 A.

[Parts per 100,000.]

Number of Filter.	Rate. Gallons per Acre Daily.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.
3 B,	2,834,000	.29	.0013	.0091	.21	.027	.0000	.29
8 A,	3,678,000	.29	.0017	.0086	.21	.027	.0001	.29

Intermittent and Continuous Filtration of Water more polluted than Merrimack River Water.

The water of the Merrimack River, while seriously polluted by the large volume of sewage flowing into it from the cities and towns on its watershed above Lawrence, and unsafe for domestic purposes without filtration because this sewage pollution brings disease germs into it, does not, as it flows by Lawrence, contain enough organic matter to prevent the presence in it of oxygen at all seasons of the year. The presence of this dissolved oxygen is the reason that continuous filtration of this water is successful.

During the past year two filters, containing 5 feet in depth of sand of an effective size of 0.23 millimeter, have been in operation, re-

ceiving water more seriously polluted than that of the river and hence containing less dissolved oxygen. The water applied to these filters is river water to which a certain proportion of sewage was added and then the mixture allowed to stand for a period before flowing upon the filters. This period of standing was for the purpose of exhausting more of the oxygen of the river water than would have been exhausted if the mixture had been applied directly to the filters. One of the filters was operated continuously and the other one intermittently.

Average Analysis of the Water applied to Filters Nos. 68 and 69.

[Parts per 100,000.]

Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid		Nitrates.	Nitrites.		
.47	.1958	.0432	.64	.025	.0014	.46	186,000

An examination of this table shows that the water applied to these two filters has contained eleven times as much free ammonia, two and one-half times as much organic matter determined as albuminoid ammonia, and twenty-four times as many bacteria per cubic centimeter as the river water. (See table, page 532.) In regard to the oxygen dissolved in the water, it can be stated that it averaged much less than that in the river water and was much more variable in amount from day to day, but was never found to be entirely absent in the water when applied to these two filters, except upon one occasion. The filters were put in operation May 19 at the rate of 5,000,000 gallons per acre daily; this rate was reduced May 25 to 2,500,000 gallons per acre daily, and on August 20 to 1,000,000 gallons per acre daily and continued at this rate for the remainder of the year. As stated before, Filter No. 68 was operated continuously and Filter No. 69 intermittently. Dissolved oxygen was always present in the effluent of Filter No. 69 while it was not found in the effluent of Filter No. 68 on numerous occasions during the warm weather. The average amount — percentage of saturation — found up to December 31, in the effluent of Filter No. 68, was 8.70, and in the effluent of Filter No. 69, 43.30. During the first two months of operation both filters gave effluents containing high numbers of bacteria and showing only

a small reduction of the organic matter of the applied water. During the remainder of the year much better results were obtained from both filters but especially from intermittent Filter No. 69.

Average Monthly and Yearly Bacterial Efficiency of Filters Nos. 68 and 69.

[May to December, inclusive, 1896.]

Number of Filter.	Method of Operation.	Average Per Cent. of Bacteria Removed — May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
68, . . .	Continuous, .	49.30	14.83	87.72	90.75	95.53	97.02	96.03	98.43	76.89
69, . . .	Intermittent, .	80.00	73.70	93.25	99.10	98.53	99.49	99.34	99.88	91.80

During December the average daily number of bacteria found in the effluent of Filter No. 68 was more than 2,000, while in Filter No. 69 it was less than 200, and it is apparent from this table that the filters improved in bacterial efficiency steadily from May to December. It is also apparent that the intermittent filter improved faster and obtained a higher degree of efficiency than the continuous Filter No. 68.

The average rate of filtration was about the same, but in order to maintain the rate, Filter No. 69 was scraped more frequently than Filter No. 68, on account of the frictional resistance to the flow of water caused by the gelatinous organic matter left in the surface layers of the sand by this highly polluted water and its power to hold the air introduced by the surface exposure of this intermittent filter. It is probable that raking the filter would have been as effective in many instances as scraping, and of course more economical.

The chemical purification of the applied water that was effected by these two filters is shown by the following table: —

Effluent of Filters Nos. 68 and 69.

[Parts per 100,000.]

Number of Filter.	Average Rate. Gallons per Acre Daily.	Color.	Ammonia. Free.	Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrites.	Oxygen Consumed.
68, ...	1,766,000	.40	.1666	.0292	.64	.043	.0016	.32
69, ...	1,831,000	.25	.0885	.0183	.64	.147	.0018	.25

Omitting the results obtained during the first two months of operation of these filters, we have the following averages: —

Effluent of Filters Nos. 68 and 69.

[Parts per 100,000.]

Number of Filter.	Average Rate. — Gallons per Acre Daily.	Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Free.	Albuminoid.		Nitrates.	Nitrites.		
68, ...	1,447,000	.35	.1462	.0250	.67	.026	.0018	.34	7,200
69, ...	1,371,000	.24	.0175	.0131	.67	.160	.0014	.26	1,754

For further details in regard to these filters see pages 558 to 564.

Double Filtration of Highly Polluted Waters.

By the filtration of a highly polluted water through filters Nos. 68 and 69, a considerable degree of purification has been obtained. This is especially true of the results obtained by intermittent Filter No. 69, which towards the end of the year produced an effluent not only quite pure chemically but with comparatively low numbers of bacteria. Whether a water of the character of that applied to these filters would, with the purification obtained by Filter No. 69 towards the end of the year, be a safe water for domestic purposes is a subject of considerable importance, but not one upon which much data can be given at the present time. A study of the degree of purification to be obtained by a second filtration of this water, that is, a filtration of the effluent of filters Nos. 68 and 69, was begun September 18. A filter containing 5 feet in depth of sand of an effective size of 0.23 millimeter was put in operation, receiving the combined effluents at the rate of 5,000,000 gallons per acre daily. This applied water stood in a wooden collecting basin before going to the filter, and the number of bacteria increased either by growth or contamination, so that, as applied to the filter, its bacterial contents were somewhat higher than when flowing from filters Nos. 68 and 69. This last filter was designated Filter No. 79, and during the first two months of operation its bacterial efficiency was low, being only 54.10 per cent., due, in part, it is now believed, to the passage of a small percentage of the water down the side of the filter, and

not through the sand. At any rate, when this was suspected and the filter reconstructed upon November 20, the bacterial efficiency of the filter became slightly higher.

The main cause of the low efficiency, however, was undoubtedly due to the fact that the water applied to the filter had already passed through the 5 feet of sand in either Filter No. 68 or No. 69 and been largely relieved of that organic matter originally present in it which is deposited upon the sand grains and forms the gelatinous coating so important in producing satisfactory bacterial results. It will be remembered in this connection that in the report of the Board for 1894, pages 586 to 589, inclusive, results obtained by applying Lawrence city (filtered) water to five sand filters are given and discussed. In this experiment the filters used had all been in operation filtering river water during the previous year, and although they had remained out of operation for a period of several months immediately preceding the application to them of this filtered water, yet their sand grains held a considerable coating of organic matter, as shown by the tables on pages 602–604, in the same report. Notwithstanding this fact, however, "it was not until their fourth week of operation that the number of bacteria in any of the effluents became as low as that in the city water applied," and the decrease after this period was very gradual.

With Filter No. 79, then, constructed of clean sand almost entirely free from organic matter, it is not surprising that even a longer period has been required to obtain a condition of the sand capable of giving satisfactory bacterial efficiency, even though the filtered water applied has not averaged so free from organic matter as the city filtered water applied to the filters in 1894 in the experiment referred to.

If a water containing more organic matter had been applied to Filter No. 79, a shorter period of low efficiency would have resulted, because the sand grains would have become more quickly covered with this organic matter.

Increased Numbers of Bacteria found in the Effluents of Filters after standing closed for Twenty-four Hours.

Bacterial analyses show that the number of bacteria in the effluent from the water filters increased when the filters stood inoperative for twenty-four hours. In order to make repairs the water was drawn out from the Essex Company's canal frequently during the year, and at such times the outlets of the water filters were shut and

the filters allowed to stand with their surfaces covered with water. Unusually great numbers of bacteria were found in some of their effluents when they were again put into operation.

Average Number of Bacteria per Cubic Centimeter in the Effluents from the Water Filters before and after standing closed.

	Filters Numbers —								
	3 B.	7 A.	8 A.	18.	33.	43.	62.	63.	64.
Day before, . . .	24	59	16	42	49	32	47	31	90
Day after, ...	24	127	39	102	681	153	174	124	313

From this table it is apparent that intermittent Filter No. 3 B was less affected than its continuous mate, Filter No. 8 A. It is also apparent that the continuous Filter No. 33, constructed of fine sand and operated at a low rate, was affected in a greater degree than were any of the other filters. It is also true that the water which passed through it was deprived of its dissolved oxygen to a greater degree than in the instance of the other filters, because the slow rate of filtration and the compactness of the sand gave a great opportunity for the organic matter in the sand to combine with the oxygen carried in the water.

Average Per Cent. of Saturation of Dissolved Oxygen in the Effluents from the Water Filters, 1896.

	Filters Numbers —							
	3 B.	7 A.	8 A.	33.	43.	62.	63.	64.
Per cent. of saturation, ...	84	58	67	40	71	45	51	56

In this table the average per cent. of saturation of the effluent of Filter No. 33 is given as 40, but as an actual matter of fact the effluent from Filter No. 33 often contained less than 1 per cent. of the oxygen necessary for saturation.

When the filters were put into operation after standing inoperative, analyses of the effluents collected at different hours showed that the number of bacteria per cubic centimeter was greater in the first portion of the effluent than in the portion of the effluent which issued after the filter had been in operation for several hours. This is well shown in the following table: —

Number of Bacteria per Cubic Centimeter in the Effluent from Filters Nos. 8 A, 33 and 43, after standing closed for Twenty-four Hours, Nov. 15, 1896.

Filter Number.	In Samples collected after the Valve had been Open for —					
	5 Minutes.	1 Hour.	2 Hours.	4 Hours.	6 Hours.	8 Hours.
8 A,	11	16	13	21	13	15
33,	82	235	216	113	98	44
43,	528	149	96	117	112	100

These samples were collected in November, when the applied water was nearly saturated with dissolved oxygen and the dissolved oxygen in the effluent from Filter No. 33, for the month, averaged 80 per cent. of that necessary for saturation.

After Filter No. 33 A had stood closed for several hours, in warm weather, the effluent often contained great numbers of bacteria, as shown in the following table: —

*Number of Bacteria per Cubic Centimeter in the Effluent from Filter No. 33 A, on Sept 21, 1896.**

In Samples collected after the Valve had been Open for —						
5 Minutes.	1 Hour.	2 Hours.	4 Hours.	6 Hours.	8 Hours.	24 Hours.
1,608	1,245	1,143	1,040	632	558	118

* The filter stood closed over Sunday, September 20.

The high numbers of bacteria found in the effluent might have been due to several causes. For instance, the bacteria might have grown on the organic matter in the sand, or the mechanical disturbance made by opening the valve suddenly might have formed channels through the sand, or the bacteria which were present in the water before closing might have multiplied gradually.

In order to determine which of these factors was the probable cause of the high numbers, city water was applied to Filter No. 33 on September 25 and 26. Up to September 24 canal water had been applied to Filter No. 33, and city water was now applied because it contained certain characteristic and easily identified species of bacteria. After the filter had become seeded with these

species they ought to have multiplied abundantly if the increase was due to the fact that the bacteria fed on the organic matter in the sand. Analyses showed, however, that the majority of the bacteria, forming the high numbers in the effluent, did not belong to the species which were characteristic of the city water.

When the filter was put into operation again on September 28, after standing closed for twenty-four hours, canal water was applied as usual, and if any channels had been formed in the sand, the number of bacteria in the effluent ought to have been greatest when the canal water first worked its way through the filter. The applied water required about eight hours to pass through the sand, and as a matter of fact the numbers of bacteria had begun to decrease by that time, as shown in the following table: —

Number of Bacteria per Cubic Centimeter in the Effluent from Filter No. 33 A, on Sept. 28, 1896.

After the Valve had been Open for —								
5 Minutes.	1 Hour.	2 Hours.	4 Hours.	5 Hours.	6 Hours.	8 Hours.	10 Hours.	24 Hours.
2,394	2,646	2,145	3,696	6,072	2,898	1,932	1,071	372

This table shows the numbers of bacteria found in the effluent increased from the first to the fifth hour and then decreased steadily. It is evident, therefore, that the high numbers were not due to the presence of canal water, which had been purified only partially in its passage through the sand. Experiments made on other days showed that the number of bacteria found in the effluent decreased steadily from the time when the valve was first opened. This is well illustrated by the table on page 527.

In order to make a more complete test for channels through the sand, a pure culture of *B. prodigiosus* was added to the applied water on September 26 and 28, but the organism was found in only two samples of the effluent. Had there been any channels through the sand it would have appeared in greater numbers.

The bacteria which were most common in the effluent belonged to a single species, as is shown in the following table, giving the number of bacteria which belonged to each of the four species found most frequently in the effluent from Filter No. 33 A on Sept. 28, 1896: —

[Bacteria per Cubic Centimeter belonging to the Different Species.]

In Sample collected after Valve had been open—	Species No. 3.	Species No. 5.	Species No. 6.	Species No. 7.
5 minutes,	0	7	2,200	187
1 hour,	0	12	2,400	223
2 hours,	17	0	2,000	128
4 hours,	5	6	3,200	349
5 hours,	10	10	5,500	535
6 hours,	32	9	2,572	250
8 hours,	18	4	1,909	10
10 hours,	7	8	1,051	4
24 hours,	5	56	154	0

This table indicates that an average of about 65 per cent. of the bacteria found in the effluent belonged to species No. 6, one of the class of bacteria which is known as *Facultative Anaërobes*, or bacteria which can grow without access to air. Attention has already been called to the fact that this species was especially prevalent in the portion of the effluent which issued during the first six hours, when the water contained the smallest amount of dissolved oxygen.

These bacteria appeared in the effluents from the various other filters, but in smaller numbers.

The results of the foregoing experiments and analyses indicate that the high numbers of bacteria, which appeared in the effluents from filters after they had stood closed for twenty-four hours, were not due to a growth of many kinds of bacteria on the organic matter in the sand, nor to channels in the sand made by throwing the valve open suddenly, but were largely due to the natural multiplication of a single species.

Period of Service of a Filter and its Influence upon Bacterial Efficiency.

The efficiency of a filter in removing bacteria increases as the organic matter upon and between the sand grains increases. The volume of water that can pass through the filter in a given time decreases as the organic matter increases. A new filter containing sand of an effective size of 0.23 millimeter, such sand as in filters Nos. 3 B and 8 A, will, with an acting head equal to the depth of the filter, allow water to pass at the rate of 43,000,000 gallons per acre daily; the desired rate of filtration being obtained by checking the flow at the outlet of the filter. As the surface clogs, this need of checking the flow grows less, until even with the outlet gate wide open and with an acting head equal to the depth of the filter the rate of flow will not be equal to the rate of filtration desired. The filter

surface is then scraped and the removal of sediment and organic matter puts the main body of sand in a condition such that its maximum rate is nearly or quite equal to its initial maximum rate. As the filter continues in operation, however, the organic matter gradually penetrates deeper into the body of sand, so that the maximum rate becomes decidedly less, even with a freshly scraped filter surface. This organic matter not only retards the flow of water but acts in the same manner as the surface scum or schmutzdecke in removing bacteria, and is of especial value in making good bacterial efficiency possible when the filter is first put into operation after a surface disturbance.

At the end of 1896, after filters Nos. 3B and 8A had been in operation for more than three years, an examination of the sand in each filter showed the following amounts of nitrogen present in parts per 100,000 by weight of dry sand: —

Nitrogen.

[Parts per 100,000.]

Depth (Inches).	Filter No 3 B (Intermittent).	Filter No. 8 A (Continuous).	Depth (Inches).	Filter No. 3 B (Intermittent).	Filter No. 8 A (Continuous).
0-1, ...	35.4	38.4	18, ...	2.1	2.8
3, ...	15.9	26.2	24, ...	1.8	2.9
6, ...	8.6	16.4	36, ...	2.0	1.8
9, ...	5.8	8.0	40, ...	2.0	1.8
12, ...	3.6	6.2			

The total amount of organic matter upon the grains of sand is shown more clearly by the following table, giving the per cent. by weight of dry sand which the samples, taken from the different depths in the filter, lose upon ignition: —

Loss on Ignition.

[Per Cent. of Weight.]

Depth (Inches).	Filter No 3 B (Intermittent).	Filter No 8 A (Continuous).	Depth (Inches).	Filter No. 3 B (Intermittent).	Filter No. 8 A (Continuous).
0-1, ...	1.31	1.21	18, ...	0.49	0.49
3, ...	0.76	0.88	24, ...	0.48	0.49
6, ...	0.62	0.73	36, ...	0.50	0.43
9, ...	0.54	0.57	40, ...	0.44	0.37
12, ...	0.54	0.58			

Beach Sand and Berkshire Sand.

Upon Sept. 2, 1895, a filter was constructed containing 48 inches in depth of sand obtained from Plum Island, twenty miles from Lawrence, upon the seashore. The object of this filter was to study the efficiency in water filtration of sand from a different locality, and perhaps of a differently shaped grain from the sands of the vicinity of Lawrence which had been used in all the water filters previously constructed at the station.

Two filters were also constructed at the same time of Berkshire sand, a white, sharp, pure quartz sand, such as is used in the manufacture of glass. These filters contained 24 and 12 inches in depth of sand respectively.

During the first year of operation of Filter No. 62, containing the beach sand, its bacterial efficiency was 98.93 per cent., and during its second year its efficiency was 99.25 per cent. Its rate of operation for the two years was 4,700,000 and 4,880,000 gallons per acre daily respectively. Comparing these results with those obtained by filters Nos. 48 and 49, in operation during 1893, 1894 and 1895, and containing Lawrence sand of about the same effective size as the beach sand, shows that the beach sand was fully as efficient as the Lawrence sand. The same statement can also be made in regard to the Berkshire sand.

The Water taken from the Merrimack River and applied to the Experimental Filters.

The water applied to the filters during 1896 has been Merrimack River water taken from the Essex Company's canal. The large 12-inch pipe from the canal to the station was removed during the year and a new 6-inch pipe laid. This new pipe is under ground, while the 12-inch pipe was above ground and could not be used during cold weather, making us dependent upon water drawn through a small pipe from the canal. With the new pipe an ample supply can be obtained at all seasons.

The results of the analyses of the water as it flows upon the filters are given in the next two tables; the first giving the average daily results of two or more bacterial determinations and the second giving the monthly averages of the chemical analyses, together with the results of bacterial determinations of samples taken at the same time that the samples for chemical analysis were taken.

Average Daily Number of Bacteria per Cubic Centimeter in the Canal Water, 1896.

Day of Month	January.	February	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	9,200	5,600	-	5,300	2,000	9,100	16,000	1,900	3,400	20,000	4,400	3,400
2,	5,700	-	-	4,100	2,200	5,600	9,200	-	10,200	71,000	5,800	4,200
3,	6,600	3,200	-	3,300	-	3,900	4,200	4,800	17,000	91,000	6,400	4,900
4,	4,700	2,800	-	1,700	1,600	1,200	-	2,900	30,000	-	3,600	6,300
5,	-	5,800	-	-	2,700	1,200	-	4,300	7,500	24,000	4,900	2,800
6,	4,400	10,600	-	4,200	3,600	2,600	1,000	2,100	-	5,200	3,700	-
7,	6,100	21,300	-	1,700	2,900	-	1,250	2,900	-	26,000	-	7,000
8,	5,300	24,000	-	2,100	2,400	7,900	10,000	2,000	18,000	19,000	-	2,400
9,	6,500	-	-	2,800	1,900	13,000	10,000	-	11,000	15,000	5,600	6,900
10,	7,200	31,000	-	4,400	-	22,000	5,200	6,800	11,000	16,000	16,000	12,000
11,	9,600	21,000	-	4,900	1,700	12,000	5,300	4,200	8,400	-	6,900	9,200
12,	-	15,000	7,800	-	6,100	8,500	-	5,600	14,000	5,100	4,700	7,800
13,	14,100	13,000	7,900	3,200	5,700	6,200	21,000	7,000	-	5,400	6,500	-
14,	9,800	12,000	6,000	3,200	5,600	-	5,200	5,800	9,100	18,000	9,900	10,300
15,	13,800	9,000	-	7,300	5,200	2,200	12,000	2,600	6,200	16,000	-	6,700
16,	10,500	-	13,000	6,500	7,000	3,900	8,400	-	21,000	3,000	6,100	13,000
17,	9,300	16,000	8,100	2,900	-	3,600	3,300	2,000	45,000	5,600	6,000	8,800
18,	11,000	14,000	5,200	4,000	6,000	9,100	3,200	1,300	40,000	-	4,700	15,000
19,	-	13,000	5,500	-	5,600	12,000	-	2,500	32,000	3,450	7,800	14,000
20,	17,000	13,000	9,400	6,500	8,300	11,000	3,000	3,800	-	5,400	6,000	-
21,	9,400	13,000	3,600	3,600	14,000	-	3,600	1,900	36,000	4,400	6,100	14,000
22,	7,000	5,200	-	3,000	8,000	13,000	1,800	2,800	21,000	4,000	-	11,000
23,	3,800	-	6,300	3,300	7,700	8,000	2,000	-	17,000	5,900	11,000	9,800
24,	11,000	11,000	5,300	4,000	-	6,000	2,200	1,250	19,000	8,000	7,100	13,000
25,	5,500	16,000	10,000	2,500	10,700	7,200	2,000	2,600	21,000	-	8,400	-
26,	-	12,000	3,500	-	11,000	16,000	-	5,400	16,000	5,000	8,400	12,000
27,	7,900	-	1,400	1,500	16,000	6,200	3,500	7,700	-	4,400	18,000	-
28,	4,900	-	5,800	2,800	42,000	-	4,300	4,400	5,300	2,900	17,000	11,000
29,	4,800	-	-	1,900	30,000	5,500	6,000	2,700	4,900	2,600	-	8,700
30,	3,800	-	8,600	2,200	12,000	4,500	4,100	-	22,000	5,100	6,200	13,000
31,	6,700	-	4,900	-	-	-	3,000	2,100	-	3,400	-	9,700

Monthly Averages of Analyses of Canal Water (Merrimack River).

[Parts per 100,000.]

1896.	Temperature. Deg F.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Soluble.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
January,	36	.40	.0060	.0153	.0166	.20	.023	.0000	.46	96	5,100
February,	34	.45	.0053	.0166	.0142	.16	.023	.0000	.45	97	18,900
March,	35	.30	.0032	.0128	.0106	.18	.014	.0000	.34	100	6,500
April,	47	.40	.0021	.0158	.0129	.15	.010	.0000	.38	100	[illegible]
May,	62	.39	.0062	.0162	.0144	.18	.013	.0000	.55	90	3,800
June,	69	.46	.0137	.0155	.0163	.19	.016	.0000	.41	51	9,000
July,	76	.34	.0134	.0177	.0164	.27	.012	.0001	.26	66	3,900
August,	77	.31	.0140	.0182	.0167	.26	.012	.0003	.29	72	4,400
September,	65	.33	.0110	.0194	.0175	.24	.017	.0004	.36	77	5,700
October,	55	.48	.0095	.0220	.0206	.23	.017	.0003	.48	82	11,500
November,	45	.51	.0074	.0193	.0167	.19	.014	.0001	.53	96	4,800
December,	36	.49	.0097	.0197	.0169	.21	.020	.0000	.50	100	7,700
Average,	53	.40	.0085	.0177	.0159	.21	.016	.0001	.41	85	6,800

Application of Bacillus Prodigiosus.

Pure cultures of *B. prodigiosus* were applied, together with the canal water, to filters Nos. 3 B, 7 A, 8 A, 33, 43, 68, 69 and 79, at different periods from July to November. The method of applying the germs has been described in earlier reports (see annual report of the Board for 1892, page 529), and during 1896 the same system has been followed, except that they were applied in smaller numbers. The pure culture of *B. prodigiosus* was prepared for application by inoculating a solution containing one-tenth of a per cent. of peptone and two-tenths of a per cent. of glucose dissolved in city water with a pure culture of the bacilli and allowing them to grow four days at 20 degrees C. This mixture was applied to filters Nos. 3 B, 7 A and 8 A, from July 1 to October 6, in the proportion of one part of the mixture to 170,000 parts of canal water, at intervals of one hour for ten hours a day on six days in a week.

From July 26 to November 30 the mixture was applied to filters Nos. 68 and 69, and from October 27 to November 30 the mixture

was applied to Filter No. 79, in the proportion of one part to 170,000 parts of canal water.

As has been stated on page 525, the effluent from Filter No. 33 A often contained great numbers of bacteria. In order to determine whether these organisms worked their way through the filter by channels in the sand, the *B. prodigiosus* mixture was applied to 33 A, in the proportion of one part to 170,000 parts of canal water, from July 14 to 28. On September 21 the amount was doubled and the mixture applied for two weeks in the proportion of one part to 85,000 parts of canal water. On October 26 and 30, November 6 and 16, the mixture was applied for one day in the same proportion.

Besides the filters already mentioned, Filter No. 43 was tested on November 16 by the application of one part of mixture to 85,000 parts of canal water.

The following table contains the average number of *B. prodigiosus* cells per cubic centimeter in the applied water: —

Average Number per Cubic Centimeter of Bacillus Prodigiosus in Applied River Water for Ten Hours Daily, 1896.

Day of Month.	July.	August.	September.	October.	November.
1,	253	76	200	82	-
2,	235	-	-	59	35
3,	-	94	-	135	100
4,	-	129	224	-	65
5,	-	94	71	182	100
6,	359	112	-	171	106
7,	412	118	-	129	76
8,	12	-	200	388	-
9,	1,635	-	147	-	100
10,	91	124	282	112	94
11,	59	106	265	-	53
12,	-	88	271	65	53
13,	159	106	-	-	-
14,	94	129	153	124	-
15,	429	-	94	141	-
16,	235	-	129	-	68
17,	188	59	271	-	129
18,	212	6	82	-	71
19,	-	118	200	-	-
20,	271	1,094	-	182	65
21,	229	835	294	271	-
22,	165	59	-	376	-
23,	424	-	129	135	129
24,	694	65	294	-	53
25,	-	59	-	-	71
26,	-	94	94	106	-
27,	141	76	-	376	124
28,	41	412	-	94	200
29,	200	200	129	-	-
30,	106	-	147	-	88
31,	212	147	-	-	-

Work of the Water Filters, 1896.

The remainder of this report upon water filtration gives the details in regard to the construction and operation of the water filters, together with tables of the results obtained.

Filter No. 3 B.

This intermittent filter, one two-hundredth of an acre in area, was started Sept. 23, 1893, and contained 60 inches in depth of sand of an effective size of 0.23 millimeter. The history of this filter up to Jan. 1, 1896, has been published in the annual reports of the Board. The method of treatment and the points in connection with the operation of the filter which were of special importance during 1896 are described in the following paragraphs.

The whole number of gallons filtered during the year amounted to 4,630,261, and the rate averaged 2,867,000 gallons per acre daily. The gate in the canal water pipe was closed daily (excepting Sundays) at 5 A.M. The surface became and remained uncovered for two hours during the warmest part of the day as a result of this treatment. On October 31 a roof of heavy planking was built over the filter in order to protect it from the weather; on November 12 the top and sides of this roof were covered with two feet of sand. From June 13 to 19 Filter No. 3 B ran continuously. During the years 1893, 1894, 1895 and part of 1896 the filter ran continuously on Sunday, excepting when closed, but after Nov. 1, 1896, the filter ran intermittently on Sunday, excepting when closed. The largest of the two pipes which supplied the filter with canal water was closed on account of cold weather in November, 1895. The rate of Filter No. 3 B was therefore reduced to 1,500,000 gallons per acre daily from Nov. 24, 1895, to April 19, 1896. On April 20 the rate was increased to 4,000,000 gallons per acre daily; and the rate was again increased on June 29 to 5,000,000 gallons per acre daily. On the days when the gate was opened after scraping, and on several days after the filter had stood closed for several hours on account of low water in the canal, the filter ran continuously for twenty-four hours. High water in the river flooded the filter on March 1, and the gate in the effluent pipe was shut until March 9. On March 10 the filter was drained, the river silt scraped from the surface and the filter filled slowly with city water from below.

Owing to the fact that the water was drawn down in the canal, the gate on the outlet had to be closed for periods varying from three to four hours on the following dates: January 4, 12, 26, February 6, 9, 16, May 2, 16, 23, 30, June 27, July 11, 25, August 1, 11, September 12, 19, 26, October 17, November 7, 14. The gate was also closed on the following dates for longer periods: during the freshet on March 1 the gate was closed for two hundred and fifty-four hours; for sixty-nine hours while the new canal pipe was being laid, on August 7, 8, 9; and for sixty-three hours on September 5, 6, 7. During all of these periods the filter remained covered with water.

In order to remove clogging at the surface, one-half an inch of sand (approximately) was removed by scraping the surface on January 3, 29, February 11, May 11, 27, June 17, July 7, 21, August 5, 13, 31, September 24, October 13, 22, 29, November 10, 19, December 10, 31. After scraping the surface, the filter was raked to a depth of 1 inch and city water was applied slowly from below until it covered the surface. After the surface became covered, canal water was applied and the filter put into operation, as soon as the depth of water on the surface reached 16 inches. On March 24 a strip 3 feet wide was scraped across the filter, the sand below this strip was then spaded 6 inches deep, and canal water applied at once from above. This experiment was tried in order to show the effect produced by scraping and disturbing a small section of a filter at a time. On April 8 and November 19 the whole surface was scraped, and then spaded over from 6 to 9 inches deep. Canal water was applied upon the surface instead of filling from below after scraping on April 8. A slight growth of *spirogyra* appeared on the surface of the filter during July and August. The exposure to the sun's rays while the surface was uncovered each day checked the growth of this algæ and prevented it from forming such great masses as developed upon continuous Filter No. 8 A. The mixture of *B. prodigiosus* (described on page 533) was applied to Filter No. 3 B for ten hours a day from July 1 to November 24, in the proportion of one part to 33,000 parts of canal water.

Bacteriological analyses were made each day, excepting on Sundays, of four samples of effluent collected at different hours. The average number of bacteria per cubic centimeter found in these sets of samples is given in the record of daily analyses in the following table: —

Average Daily Number of Bacteria per Cubic Centimeter in the Effluent of Filter No. 3 B, 1896.

Day of Month.	January.	February.	March.	April.	May.	June	July.		August.		September.		October.		November.		December.
							Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.	
1, . .	5	10	–	19	12	27	11	0	39	1	[illegible]	0	[illegible]	0	–	–	76
2, . .	9	–	–	18	17	29	18	0	–	–	78	2	6	0	[illegible]	0	64
3, . .	10	12	–	15	–	18	[illegible]	0	17	0	89	1	18	0	12	0	96
4, . .	53	12	–	13	31	11	1	0	7	0	62	0	–	–	6	0	[illegible]
5, . .	–	17	–	–	19	19	–	–	32	0	40	3	37	0	7	0	104
6, . .	25	16	–	11	15	85	38	0	38	0	–	–	6	0	20	0	–
7, . .	32	88	–	10	6	–	[illegible]	0	46	3	–	–	14	0	12	0	[illegible]
8, . .	11	111	–	213	5	14	48	0	–	–	28	1	7	0	–	–	88
9, . .	12	–	–	47	14	21	32	0	–	–	14	0	7	0	27	0	44
10, . .	17	16	–	44	–	12	38	3	60	1	18	0	7	0	18	0	24
11, . .	27	8	–	38	18	14	19	2	40	0	22	0	–	–	28	0	75
12, . .	–	116	38	–	11	8	–	–	18	0	9	0	17	1	26	0	395
13, . .	42	139	99	27	27	7	89	0	–	–	–	–	5	0	16	0	–
14, . .	62	89	57	23	19	–	34	0	59	0	20	0	28	0	14	0	[illegible]
15, . .	57	69	–	19	18	9	32	0	80	0	15	0	26	1	–	–	179
16, . .	[illegible]	–	90	17	13	9	33	0	–	–	7	0	14	0	40	0	268
17, . .	69	108	38	26	–	19	45	0	23	0	21	0	4	0	39	0	212
18, . .	43	61	28	16	17	24	50	0	24	0	4	0	–	–	5	0	238
19, . .	–	36	[illegible]	–	18	20	–	–	7	1	7	0	25	1	26	0	265
20, . .	94	47	9	99	25	16	34	0	12	0	–	–	24	1	–	–	–
21, . .	45	25	13	16	18	–	20	0	12	0	25	1	6	0	–	–	139
22, . .	11	88	–	10	10	20	26	0	13	0	30	1	13	0	–	–	100
23, . .	6	–	11	17	29	5	27	2	–	–	10	0	42	2	–	–	78
24, . .	[illegible]	90	148	12	–	24	13	1	10	0	32	0	60	1	308	–	90
25, . .	5	60	171	43	12	14	20	0	15	0	35	0	–	–	398	–	–
26, . .	–	35	69	–	10	5	–	–	13	0	76	0	40	0	–	–	53
27, . .	4	–	66	11	16	7	13	0	14	0	–	–	31	0	288	–	22
28, . .	5	–	–	15	26	–	13	0	12	0	31	0	20	0	163	–	51
29, . .	4	–	–	10	73	16	15	0	6	0	21	1	12	0	–	–	35
30, . .	16	–	55	7	62	16	11	0	–	–	6	0	38	0	103	–	26
31, . .	32	–	30	–	–	–	27	0	11	0	–	–	12	0	–	–	–

Effluent of Filter No. 3 B.

[Parts per 100,000.]

[illegible]	Quantity of Effluent. — Gallons per Acre Daily	Temperature, Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid		Nitrates.	Nitrites.			
January, . .	1,186,000	35	36	.35	.0011	.0100	[illegible]	.032	0	.27	94	22
February, .	1,401,000	34	40	.35	[illegible]	.0066	.16	.027	0	.33	94	42
March, . .	1,482,000	[illegible]	36	.28	.0006	.0076	.17	.016	0	.36	96	60
April, . .	2,344,000	47	46	.29	.0006	.0077	.13	.015	0	.27	96	28
May, . . .	3,366,000	62	56	.26	.0006	.0069	.15	.030	0	.27	75	19
June, . .	4,083,000	69	66	.27	.0006	.0095	.21	.023	0	.27	78	14
July, . .	3,740,000	76	76	.15	.0022	.0076	.25	.028	0	.17	68	13
August, . .	3,637,000	77	76	.11	.0014	.0063	.26	.026	0	.16	67	13
September, .	3,784,000	65	63	.13	.0015	.0066	.22	.027	0	.25	74	13
October, . .	3,183,000	56	57	.28	.0010	.0100	.27	[illegible]	0	.36	61	10
November, .	2,989,000	45	43	.46	.0012	.0116	.19	.032	0	.42	[illegible]	170
December, .	2,966,000	36	36	.44	.0063	.0123	.22	.062	0	.40	96	120
Average, .	2,834,000	53	53	.30	.0013	.0091	.21	.026	0	.29	83	44

Filter No. 7 A.

This continuous filter, one two-hundredth of an acre in area, was started July 20, 1894, and contained 24 inches in depth of sand of an effective size of 0.26 millimeter. The history of the filter up to Jan. 1, 1896, has been published in the annual reports of the Board. The points in connection with the operation of the filter which were of special importance during 1896 are described in the following paragraphs.

The filter was not operated from Nov. 24, 1895, until April 13, 1896, but on the latter date was put in operation at a prescribed rate of 5,000,000 gallons per acre daily. The whole number of gallons filtered amounted to 4,813,825, and the rate averaged 4,124.000 gallons per acre daily for the period of operation. A short trap attached to the outlet prevented air from entering the filter at the bottom.

Spirogyra grew in masses and clogged the surface of the filter badly during July and August. The depth of water on the surface

of the filter was kept at 32 inches until July 1, when it was reduced to 16 inches. A roof of heavy planking was built over the filter on October 31 in order to protect it from the weather, and the top and sides of the roof were covered with 2 feet of sand on November 12.

Owing to low water in the canal the gate on the outlet was closed for periods varying from three to twenty-four hours on the following dates: May 2, 16, 23, June 27, July 11, 25, August 1, 11, September 12, 19, 26, October 17, November 7, 14, 21. The gate was closed on the following dates for a longer period of time: from April 17 to 20 for sixty-one hours, on account of high water; from August 7 to 9 for sixty-nine hours; and September 5 to 7 for sixty-three hours. During all of these periods the surface remained covered with water.

In order to remove clogging at the surface, one-half an inch of sand (approximately) was removed by scraping the surface of the filter on May 9, 30, June 25, July 15, 22, August 7, 20, September 1, 15, October 2, 14, 23, November 12, 28.

After scraping, the filter was filled slowly with city water from below, and as soon as the surface became covered canal water was turned on, and the gate on the effluent pipe opened when the depth of water on the surface reached 16 inches. After scraping and filling from below on May 30, the gate on the effluent pipe was closed for fifty hours. Instead of being scraped the surface was raked 1 inch in order to remove clogging, and the filter filled slowly from below with city water on December 24.

A mixture containing a pure culture of *B. prodigiosus* was applied for ten hours a day from July 1 to October 9, in the proportion of one part of mixture to 170,000 parts of applied canal water.

Bacteriological analyses were made each day excepting Sunday of four samples of effluent collected at different hours, and the average number of bacteria per cubic centimeter found in these samples is given in the record of daily analyses in the following table: —

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 7 A, 1896.

Day of Month.	April.	May.	June.	July. Water Bacteria.	July. B. Prodigiosus.	August. Water Bacteria.	August. B. Prodigiosus.	September. Water Bacteria.	September. B. Prodigiosus.	October.	November.	December.
1,	-	17	224	23	0	22	0	44	0	11	-	96
2,	-	13	145	16	0	-	-	109	1	22	21	108
3,	-	-	66	13	0	23	0	114	0	124	24	166
4,	-	41	45	-	-	32	0	66	0	-	41	209
5,	-	10	13	-	-	207	0	84	0	124	30	228
6,	-	13	14	6	0	723	0	-	-	61	8	-
7,	-	11	-	10	2	330	0	-	-	74	30	333
8,	1,120	13	16	13	2	-	-	167	2	39	-	217
9,	[illegible]	15	18	15	0	-	-	44	5	30	68	181
10,	1,157	-	35	13	1	356	0	22	2	30	94	116
11,	749	17	14	15	0	36	2	22	0	-	23	77
12,	-	19	12	-	-	29	2	15	0	20	26	69
13,	841	15	14	196	0	29	0	-	-	39	37	-
14,	346	16	-	24	0	22	1	97	0	39	33	45
15,	412	22	14	83	1	26	0	31	0	66	-	66
16,	263	23	16	36	1	-	-	69	1	70	60	70
17,	240	-	20	48	3	27	0	271	1	75	108	29
18,	-	66	18	31	0	18	0	79	1	-	77	2
19,	-	17	13	-	-	19	0	48	1	109	68	15
20,	329	16	13	13	0	25	1	-	-	39	41	-
21,	127	13	-	25	0	63	0	804	2	21	98	34
22,	108	15	21	40	2	45	4	58	1	26	-	23
[illegible]	75	12	11	26	0	-	-	53	1	40	[illegible]	40
24,	47	-	19	24	2	96	0	39	8	22	82	19
25,	83	13	32	17	1	89	1	38	0	-	46	-
26,	-	[illegible]	741	-	-	28	0	[illegible]	0	75	-	133
27,	20	16	183	37	1	41	0	-	-	56	[illegible]	-
28,	16	12	-	15	1	37	0	162	1	44	43	260
29,	12	18	172	28	1	24	0	35	0	11	-	172
30,	14	27	80	27	0	-	-	28	1	20	182	111
31,	-	-	-	12	0	15	0	-	-	17	-	106

Monthly Averages of Analyses of Effluent of Filter No. 7 A.

[Parts per 100,000.]

1896.	Quantity of Effluent. Gallons per Acre Daily.	Temperature. Deg. F Applied Water	Temperature. Deg. F Effluent.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
April,	5,050,000	47	51	.32	.0010	.0108	.12	.018	.0000	.30	96	117
May,	4,162,000	62	61	.29	.0008	.0089	.18	.020	.0000	.27	66	15
June,	4,626,000	69	65	.30	.0013	.0110	.30	.020	[illegible]	.26	44	108
July,	4,617,000	76	75	.16	.0023	.0078	.28	.026	.0001	.16	27	16
August,	4,842,000	77	76	.12	.0012	.0067	.25	.026	.0000	.17	18	26
September,	4,505,000	66	63	.23	.0020	.0096	.23	.029	.0000	.26	46	66
October,	4,148,000	55	57	[illegible]	.0026	.0122	.27	.037	.0000	.30	64	161
November,	2,978,000	45	48	.47	.0027	.0109	.19	.022	[illegible]	.44	74	48
December,	2,589,000	36	38	.44	.0046	.0127	.21	.037	.0000	.42	84	235
Average,	4,164,000	58	59	.29	.0021	.0102	.21	.027	[illegible]	.29	57	86

Filter No. 8 A.

This continuous filter, one two-hundredth of an acre in area, was started Sept. 26, 1893, and contained 60 inches in depth of sand of an effective size of 0.23 millimeter. The history of this filter up to Jan. 1, 1896, has been published in the annual reports of the Board. The points in connection with the operation of the filter which were of special importance during 1896 are described in the following paragraphs.

From Nov. 25, 1895, to April 19, 1896, Filter No. 8 A ran at a prescribed rate of 1,500,000 gallons per acre daily. The rate was increased to 5,000,000 gallons per acre daily on April 20, 1896. The whole number of gallons filtered during the year amounted to 5,984,000, and the rate averaged 3,694,000 gallons per acre daily for the days of operation. A trap attached to the outlet prevented air from entering at the bottom. On October 31 a roof of heavy planking was built over the filter in order to protect it from the weather, and the top and sides of this roof were covered with 2 feet of sand on November 12.

Spirogyra began to appear on the surface about July 1, and at times the water over the surface of the filter became completely filled with masses of these filaments. This growth of algæ developed

so rapidly and clogged the sand to such a degree that the surface had to be scraped four times between July 6 and August 3.

Owing to the fact that the water was drawn down in the canal, the gate on the outlet was closed on the following dates, for periods varying from three to twenty-four hours: January 12, February 9, 16, May 2, 16, 23, 30, June 27, July 11, 25, August 1, 11, September 12, 19, 26, October 17, November 7, 14, 21. The gate was closed for longer periods on the following dates: March 1 to 11 for two hundred and thirty-eight hours on account of the freshet; April 17, 18, 19 for sixty-one hours on account of high water; August 7, 8, 9 for seventy-one hours while the new canal pipe was being laid. During all of these periods the surface of the filter remained covered with water. The freshet on March 1 covered the surface of the filter with silt. On March 10 the filter was allowed to drain, the river silt removed, and the filter filled slowly from below with city water. The gate was opened on March 11 and the filter started at a prescribed rate of 1,500,000 gallons per acre daily. On August 3 canal water was applied immediately at the surface after scraping.

In order to remove clogging at the surface one-half an inch (approximately) of sand was removed by scraping on the following dates: January 4, February 6, April 11, May 21, June 15, July 6, 20, 28, August 3, 15, September 11, October 12, November 9, December 1, and after scraping, the surface of the filter was raked to the depth of 1 inch. In order to remove clogging at the surface more efficiently, the surface was spaded from 6 to 8 inches deep after scraping on April 11, August 15, December 1. The filter was usually filled slowly from below with city water after scraping, and as soon as the surface became covered, canal water was turned on and the gate on the outlet opened. On August 15 and December 1 the gate was closed for twenty-four hours after filling with city water before the filter went into operation.

B. prodigiosus mixture was applied from July 1 to October 9 in the proportion of 1 part of mixture to 170,000 parts of applied canal water, and from October 10 to 24 the mixture was applied in the proportion of 1 part to 85,000 parts of applied canal water.

Bacteriological analyses were made each day excepting Sunday of four samples of effluent collected at different hours. The average number of bacteria found in each of these sets of samples is given in the record of daily analyses in the following table: —

Average Daily Number of Bacteria per Cubic Centimeter in the Effluent of Filter No. 8 A, 1896.

Day of Month.	January.	February.	March.	April	May.	June	July		August.		September.		October.		November.		December.
							Water Bacteria	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.	Water Bacteria	B. Prodigiosus.	
1, . .	4	10	–	13	9	30	6	0	8	0	9	0	8	0	–	–	19
2, . .	5	–	–	12	11	12	7	0	–	–	11	0	9	0	21	0	–
3, . .	18	12	–	6	–	10	7	0	10	0	9	0	4	0	10	0	12
4, . .	9	21	–	10	28	6	–	–	9	0	14	0	–	–	19	0	54
5, . .	–	11	–	–	10	6	–	–	10	0	11	0	6	0	11	0	125
6, . .	50	6	–	23	10	5	15	0	13	0	–	–	13	0	9	0	–
7, . .	9	17	–	13	10	–	13	0	65	0	–	–	7	0	9	0	413
8, . .	11	21	–	9	13	10	9	0	–	–	233	0	4	0	–	–	325
9, . .	18	–	–	12	8	9	6	1	–	–	36	0	3	0	38	0	294
10, . .	17	67	83	9	–	8	10	0	81	2	185	0	6	0	12	0	166
11, . .	21	34	32	23	[illegible]	8	8	0	106	4	263	0	–	–	13	0	97
12, . .	–	21	36	–	7	4	–	–	93	6	26	0	10	0	10	0	78
13, . .	36	19	41	26	9	6	45	0	56	2	–	–	19	0	15	0	–
14, . .	40	27	47	14	21	–	8	0	17	1	14	0	18	0	34	0	54
15, . .	29	11	–	26	10	28	3	0	12	0	14	0	30	4	–	–	60
16, . .	39	–	44	18	19	18	8	0	–	–	16	0	10	0	14	–	98
17, . .	38	29	35	28	–	15	8	0	38	0	17	0	4	0	21	–	81
18, . .	26	25	38	–	37	7	9	0	28	0	9	0	–	–	29	–	68
19, . .	–	18	20	–	10	9	–	–	[illegible]	0	9	0	23	2	[illegible]	–	104
20, . .	34	17	21	57	21	8	6	0	18	0	–	–	9	1	16	–	–
21, . .	28	29	21	29	12	–	18	0	24	0	56	0	15	1	24	–	[illegible]
22, . .	32	14	–	23	32	8	10	0	15	0	10	0	5	1	–	–	[illegible]
23, . .	9	–	27	22	13	10	10	0	–	–	16	0	6	1	32	–	42
24, . .	12	15	16	21	–	8	9	0	13	0	11	0	18	0	16	–	68
25, . .	9	11	12	23	18	10	21	0	16	0	16	0	–	–	17	–	–
26, . .	–	8	12	–	9	13	–	–	37	0	19	0	9	1	–	–	51
27, . .	11	–	10	9	12	12	9	0	21	0	–	–	13	0	24	–	–
28, . .	8	–	12	18	6	–	14	0	20	0	85	0	10	0	12	–	113
29, . .	10	–	–	11	10	10	18	0	25	0	38	0	18	0	–	–	48
30, . .	10	–	9	10	11	10	8	0	–	–	9	0	8	0	15	–	42
31, . .	7	–	13	–	–	–	8	0	9	0	–	–	13	0	–	–	24

Monthly Averages of Analyses of Effluent of Filter No. 8 A.

[Parts per 100,000.]

1896.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	[illegible] as		Oxygen Consumed.	Per Cent of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid.		Nitrates.	[illegible]			
January, . .	1,756,000	35	35	.36	.0010	.0097	.20	.033	.0000	.37	86	24
February, .	1,576,000	34	35	.34	.0000	.0082	.18	[illegible]	.0000	.33	62	29
March, . .	1,778,000	36	35	.28	.0006	.0066	.17	.018	.0000	.34	57	32
April, . .	3,108,000	47	47	.30	.0007	.0075	.18	.018	[illegible]	.37	62	17
May, . . .	4,907,000	62	61	.26	.0008	.0071	.18	.025	[illegible]	.35	48	16
June, . .	4,706,000	[illegible]	66	.26	.0009	.0083	.20	.028	.0000	.32	41	16
July, . .	4,383,000	76	76	.15	.0026	.0071	.25	.025	.0010	.17	41	8
August, . .	3,597,000	77	77	.11	.0018	.0081	.27	.037	.0001	.16	46	20
September, .	4,719,000	66	63	.22	.0030	.0096	.23	.027	.0000	.26	46	110
October, . .	4,707,000	55	57	.27	.0016	.0096	.27	.045	.0000	[illegible]	66	27
November, .	4,307,000	45	43	.45	.0016	.0096	.19	.030	.0000	.42	77	25
December, .	4,397,000	36	36	.44	.0057	.0133	.21	.026	.0000	.42	80	100
Average, .	3,678,000	53	53	.29	.0017	[illegible]	.21	.027	.0001	.29	67	30

Filter No. 18 A.

This intermittent filter, 20 inches in diameter, was started Sept. 17, 1889, and contained 62 inches in depth of sand of an effective size of 0.48 millimeter. On Aug. 31, 1895, the depth of sand in the filter was reduced to 36 inches. Before the filter went into operation in 1896 the bed of sand in the filter was restored to its original depth. The history of the filter up to Jan. 1, 1896, has been published in the annual reports of the Board, and the points in connection with the operation of the filter which were of special importance during 1896 are described in the following paragraphs.

After draining, the filter went out of operation on Nov. 24, 1895. One foot of sand was taken out from the top of Filter No. 18 A on May 6, 1896, the sand remaining spaded to a depth of 1 foot, and enough sand added to restore the bed to its original depth of 62 inches. The sand used for this purpose was obtained by mixing the foot of sand taken out from 18 A with sand taken from Filter No. 50, which had been in operation during 1895 and contained sand of an effective size of 0.48 millimeter.

May 7 the filter was filled slowly from below with city water and allowed to stand over night, and on May 8 went into operation at a prescribed rate of 5,000,000 gallons per acre daily. The operation of the filter was arranged in such a manner that the surface remained uncovered for two hours during the day. The filter ran continuously on Sundays.

Owing to low water in the canal the gate on the outlet was closed on the following dates for periods varying from two to twenty-four hours: May 18, 23, June 27, July 13, August 9, 11, September 12, 19, 26, October 17, November 7. The gate was closed for a longer period of sixty-four hours on September 5, 6, 7. During all of these periods the surface remained covered with water.

In order to remove clogging at the surface the filter was scraped as follows: July 3, 0.26 of an inch of sand was removed; August 7, 0.23 of an inch; October 19, 0.49 of an inch; October 29, 0.41 of an inch; November 12, 0.44 of an inch. After scraping, canal water was applied from above without first raking the surface of the filter or filling from below with city water.

A bacteriological analysis of a sample of the effluent was made daily excepting Sundays. The number of bacteria per cubic centimeter found in these samples is given in the record of daily analyses in the following table: —

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 18 A, 1896.

Day.	May.	June.	July.	August.	September.	October.	November.
1,	-	52	13	19	83	87	-
2,	-	34	19	-	15	70	23
3,	-	32	21	14	19	194	21
4,	-	19	-	8	24	-	33
5,	-	13	-	16	23	150	21
6,	-	11	18	7	-	91	11
7,	-	-	16	25	-	44	23
8,	24,300	12	26	86	330	42	-
9,	900	22	83	-	253	62	167
10,	-	27	19	142	184	57	55
11,	450	28	34	62	37	-	32
12,	195	30	-	40	91	51	46
13,	169	15	26	43	-	20	78

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 18 A, 1896 — Concluded.

Day.	May.	June.	July.	August.	September.	October.	November.
14,	121	-	18	24	46	43	128
15,	60	9	11	24	29	33	-
16,	55	12	12	-	36	6	-
17,	-	22	60	26	60	38	-
18,	56	20	39	18	78	-	-
19,	97	18	-	26	145	138	-
20,	72	9	40	10	-	70	-
21,	63	-	29	18	420	29	-
22,	31	158	21	51	154	41	-
23,	24	32	11	-	60	62	-
24,	-	31	26	24	90	29	-
25,	28	26	17	10	39	-	-
26,	29	23	-	94	54	30	-
27,	20	13	23	60	-	56	-
28,	34	-	5	24	44	12	-
29,	65	16	13	16	19	10	-
30,	25	20	13	-	48	14	-
31,	-	-	14	8	-	17	-

Monthly Averages of Analyses of Effluent of Filter No. 18 A.

[Parts per 100,000.]

1896.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.			
May,	3,687,000	62	63	.28	.0008	.0100	.19	.026	.0000	.28	73	45
June,	4,645,000	69	72	.36	.0016	.0130	.18	.035	.0000	.41	67	65
July,	4,929,000	76	75	.16	.0010	.0084	.26	.051	.0000	.21	56	26
August,	5,026,000	77	78	.18	.0009	.0072	.29	.034	.0000	.23	64	19
September,	4,838,000	65	67	.20	.0022	.0095	.25	.046	.0000	.20	47	94
October,	4,373,000	56	64	[illegible]	.0022	.0129	.25	.025	.0000	.55	82	[illegible]
November,	4,663,000	45	50	.49	.0018	.0106	.22	.028	.0000	.43	88	11
Average,	4,580,000	64	65	.30	.0015	.0108	.24	.035	.0000	.32	68	50

Filter No. 33 A.

This continuous filter, 20 inches in diameter, was started April 28, 1892, and contained 60 inches in depth of sand of an effective size of 0.14 millimeter. The history of the filter up to Jan. 1, 1896, has been published in the annual reports of the Board, and the points in connection with its operation during 1896 which were of special importance are described in the following paragraphs.

The filter went out of operation on Nov. 24, 1895, and on May 8, 1896, was again started at a rate of 2,000,000 gallons per acre daily. A short trap attached to the outlet prevented air from entering at the bottom of the filter.

For purposes of experiment Filter No. 33 was flooded with city (filtered) water instead of canal water on September 25 for twenty-four hours; on October 22, 23 and 24; and on November 23 for twenty-nine hours.

Owing to low water in the canal the gate on the outlet was closed on the following dates for periods varying from two to twenty-four hours: May 16, 23, 30, June 27, July 11, August 9, 11, September 12, 19, 26, October 17, 24, 28, November 4, 7, 14, 21. The gate was closed for a period of sixty-two hours on September 5. During all of these periods the surface remained covered with water. As explained on pages 525–529, the bacteria found in the effluent from Filter 33 A increased very greatly in number during the periods when the gate was closed. The great number of bacteria seems to have been due to the multiplication of cells belonging to a single species, which found the conditions existing in the filter at the time to be especially favorable for their development.

In order to remove clogging at the surface the filter was scraped on the following dates: July 30, 0.31 of an inch of sand was removed; October 5, 0.44 of an inch; and November 30, 0.29 of an inch. A mixture containing a pure culture of *B. prodigiosus* was applied in the proportion of 1 part of mixture to 170,000 parts of applied canal water, from July 14 to 31; in the proportion of 1 part to 85,000 parts of applied canal water, from September 21 to October 5; and in the same proportion on November 6 and 16.

A bacteriological analysis of a sample of the effluent was made daily, excepting Sundays, up to November 1. The number of bacteria per cubic centimeter found in these samples is given in the record of daily analyses in the following table: —

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 33 A, 1896.

Day.	May.	June.	July. Water Bacteria.	July. B. Prodigiosus.	August. Water Bacteria.	August. B. Prodigiosus.	September. Water Bacteria.	September. B. Prodigiosus.	October. Water Bacteria.	October. B. Prodigiosus.	November.	December.
1,	-	669	64	0	62	0	16	0	25	2	-	-
2,	-	32	43	0	-	-	11	0	168	0	57	-
3,	-	19	14	0	14	1	66	0	148	0	-	-
4,	-	13	-	-	19	0	40	0	-	-	-	-
5,	-	16	-	-	43	0	53	0	123	0	-	-
6,	-	5	27	0	12	0	-	-	216	0	-	-
7,	-	-	13	0	15	0	-	-	43	0	-	-
8,	2,300	9	20	0	15	0	138	0	26	0	-	-
9,	500	17	74	0	-	-	121	0	18	0	-	-
10,	-	12	46	0	96	0	57	0	21	0	-	-
11,	150	12	19	0	63	0	53	0	-	-	86	80
12,	68	9	-	-	82	0	17	0	21	0	23	-
13,	65	14	-	-	73	0	-	-	17	0	71	-
14,	94	-	-	-	66	0	526	0	2	0	54	-
15,	48	15	102	1	32	0	64	0	27	0	-	-
16,	24	17	83	8	-	-	37	0	34	0	100	-
17,	-	14	70	2	49	0	78	0	41	0	22	-
18,	30	10	106	0	59	0	102	0	-	-	-	3
19,	17	11	-	-	62	0	81	0	162	0	-	-
20,	17	10	34	0	68	0	-	-	41	0	86	-
21,	29	-	30	1	43	0	632	0	30	0	-	-
22,	12	12	48	0	37	0	108	0	197	0	-	-
23,	20	33	39	1	-	-	88	2	258	0	-	-
24,	-	10	23	2	23	0	400	118	167	0	-	96
25,	32	6	15	1	15	0	258	1	-	-	-	-
26,	20	9	-	-	29	0	267	0	44	3	-	-
27,	23	4	57	0	42	0	-	-	-	-	-	-
28,	26	-	29	1	28	0	2,170	0	-	-	-	-
29,	51	86	33	0	34	0	378	0	-	-	-	-
30,	20	28	60	1	-	-	25	0	-	-	-	-
31,	-	-	19	0	26	0	-	-	24	0	-	-

Monthly Averages of Analyses of Effluent of Filter No. 33.

[Parts per 100,000.]

[redacted]	Quantity of Effluent. Gallons per Acre Daily.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.			
May,	1,446,000	62	63	.29	.0005	.0090	.19	.026	0000	.24	45	22
June,	1,970,000	69	69	.32	.0009	.0085	.18	.038	.0000	.32	28	14
July,	2,010,000	76	78	.18	.0024	.0077	.28	.026	.0012	.20	6	48
August,	1,952,000	77	74	.18	.0031	.0077	.28	.024	.0009	.23	11	20
September,	1,949,000	65	66	.19	.0026	.0096	.25	.037	.0000	.21	30	71
October,	2,015,000	55	55	.27	.0015	.0095	.26	.027	.0000	.36	55	92
November,	1,927,000	–	–	–	–	–	–	–	–	–	50	–
December,	1,927,000	–	–	–	–	–	–	–	–	–	66	–
Average,	1,900,000	67	67	.24	.0019	.0087	.24	.030	.0004	.26	41	46

Filter No. 43.

This continuous filter, 20 inches in diameter, was started May 30, 1893, and contained 60 inches in depth of sand of an effective size of 0.26 millimeter. The history of the filter up to Jan. 1, 1896, has been published in the annual reports of the Board, and the points in connection with its operation during 1896 which are of special importance are described in the following paragraphs.

From Dec. 24, 1895, to July 28, 1896, the filter was not in operation. On the latter date it was started at the rate of 5,000,000 gallons per acre daily. Owing to low water in the canal the gate on the outlet was closed for periods varying from two to twenty-four hours on the following dates: August 9, 11, September 12, 19, 26, October 17, November 7, 14, 21. The gate was also closed for a longer period of sixty-two hours on September 5, 6 and 7. During all of these periods the surface remained covered with water. In order to remove clogging at the surface the filter was scraped on the following dates: September 12, 0.53 of an inch of sand was removed; October 5, 0.37 of an inch; November 26, 0.37 of an inch; December 22, 0.51 of an inch.

After scraping, canal water was usually applied at once without raking the surface or filling from below with city water. On November 26 the surface was spaded to a depth of 4 inches, city water applied slowly from below until the surface became covered, and the gate on the outlet closed for nineteen hours.

A mixture containing a pure culture of *B. prodigiosus* was applied,

in the proportion of one part of mixture to 85,000 parts of canal water, upon November 16, but the germ did not appear in the effluent.

A bacteriological analysis of a sample of the effluent was made on each day, excepting Sundays, from July 28 to November 13. The number of bacteria per cubic centimeter found in these samples is given in the record of daily analyses in the following table: —

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 43, 1896.

DAY.	August.	September.	October.	November.	December.
1,	138	42	45	16	-
2,	-	40	87	60	-
3,	-	157	448	22	-
4,	64	99	-	14	50
5,	64	43	-	10	-
6,	27	-	88	-	-
7,	46	-	75	17	-
8,	36	116	61	-	-
9,	-	345	63	154	-
10,	891	50	44	185	-
11,	214	89	-	93	34
12,	162	25	21	91	-
13,	67	-	16	42	-
14,	61	98	32	88	-
15,	111	40	36	-	-
16,	-	40	48	82	-
17,	145	139	31	44	-
18,	105	153	-	-	4
19,	68	28	54	-	-
20,	36	-	32	-	-
21,	48	271	50	29	-
22,	34	101	57	-	103
23,	-	71	67	109	-
24,	77	57	59	-	112
25,	45	54	-	-	-
26,	66	27	61	-	-
27,	61	-	69	198	-
28,	70	42	33	-	-
29,	63	17	23	-	-
30,	-	66	-	-	-
31,	20	-	16	-	-

Monthly Averages of Analyses of Effluent of Filter No. 43.

[Parts per 100,000.]

1896.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg F.		Color.	Ammonia.		[redacted]ne.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.			
July, . .	5,080,000	–	–	–	–	–	–	–	–	–	–	–
August, . .	4,941,000	–	–	–	–	–	–	–	–	–	–	–
September, .	4,804,000	66	66	.22	.0026	.0101	.25	.036	[redacted]	.24	44	73
October, . .	4,727,000	55	54	.43	.0019	.0129	.25	.028	.0000	.54	66	77
November, .	4,774,000	45	51	.50	.0016	.0106	.21	.027	.0000	.46	82	10
December, .	4,277,000	–	–	–	–	–	–	–	–	–	98	–
Average, .	4,876,000	55	57	.38	.0020	.0118	.24	.030	.0000	.41	–	53

Filter No. 62.

This continuous filter, 20 inches in diameter, was started Sept. 2, 1895, and contained 48 inches in depth of sand of an effective size of 0.40 millimeter. The sand for this filter was obtained from the beach at Plum Island, on the seacoast, 20 miles from Lawrence. The history of the filter up to Jan. 1, 1896, has been published in the annual report of the Board, and the points in connection with the operation of this filter during 1896 which are of special importance are described in the following paragraphs.

After draining, the filter went out of operation on Nov. 24, 1895. On May 11, 1896, city water was applied slowly from below until the surface became covered, canal water turned on, and the filter put into operation at a rate of 5,000,000 gallons per acre daily. When the filter was started, on May 11, it contained 39 inches of sand. A short trap attached to the outlet prevented air from entering the filter at the bottom. On account of low water in the canal the gate on the outlet was closed on the following dates for periods varying from two to forty-two hours: May 16, 23, 30, June 27, July 11, August 10, 11, September 12, 19, 26, October 17, November 7. The gate was closed for a longer period of sixty-two hours on September 5, 6, 7. During all of these periods the surface remained covered with water.

On May 25 the surface was found uncovered, therefore city water was applied slowly from below and canal water turned on as soon

as the surface became covered. In order to remove clogging, the surface was scraped on the following dates: July 6, 0.40 of an inch of sand was removed; July 27, 0.36 of an inch; August 11, 0.39 of an inch; August 25, 0.34 of an inch; September 11, 0.30 of an inch; October 2, 0.33 of an inch; October 28, 0.28 of an inch; November 10, 0.48 of an inch. After scraping, canal water was applied at once, without raking the surface or filling the filter from below with city water.

A bacteriological analysis of the effluent was made on each day excepting Sundays. The number of bacteria per cubic centimeter found in these samples is given in the record of daily analyses in the following table: —

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 62, 1896.

Day.	May.	June.	July.	August.	September.	October.	November.
1,	-	91	62	26	32	41	-
2,	-	2,506	29	-	38	40	27
3,	-	32	21	23	32	221	18
4,	-	24	-	15	27	-	28
5,	-	32	-	25	45	87	20
6,	-	40	19	12	-	86	16
7,	-	-	19	17	-	100	5
8,	-	28	13	26	161	76	-
9,	-	33	52	-	59	70	134
10,	-	35	683	99	52	26	86
11,	2,150	23	24	43	36	-	63
12,	485	26	-	107	40	26	43
13,	728	19	220	60	-	71	79
14,	427	-	17	39	44	54	56
15,	124	17	27	35	35	77	-
16,	335	11	85	-	54	73	-
17,	-	16	130	42	86	42	-
18,	523	28	43	27	102	-	-
19,	70	23	-	94	32	65	-
20,	73	12	14	36	-	69	-
21,	61	-	72	43	693	53	-
22,	66	22	55	17	87	20	-
23,	20	23	418	-	67	28	-
24,	-	23	20	28	86	19	-
25,	183	28	9	38	31	-	-
26,	63	21	-	35	38	21	-
27,	50	17	96	51	-	39	-
28,	43	-	22	37	36	29	-
29,	55	24	83	27	21	27	-
30,	39	23	47	-	29	-	-
31,	-	-	15	20	-	22	-

Monthly Averages of Analyses of Effluent of Filter No. 62.

[Parts per 100,000.]

1896.	Quantity of Effluent. — Gallons per Acre Daily	Temperature, Deg. F: Applied Water.	Temperature, Deg. F: Effluent	Color.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as: Nitrates.	Nitrogen as: Nitrites.	Oxygen Consumed.	Per Cent of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
May, . . .	5,068,000	62	[illegible]	.29	.0008	.0114	.19	.022	.0000	.27	66	106
June, . .	4,979,000	69	69	.35	.0015	.0105	.18	.036	.0000	.35	33	34
July, . .	4,894,000	76	73	.17	.0019	.0099	.29	.030	.0031	.23	10	32
August, . .	4,681,000	77	74	.19	.0021	.0061	.28	.032	.0008	.24	29	26
September, .	4,897,000	65	66	.21	.0019	.0105	.25	.035	.0000	.25	33	60
October, . .	4,884,000	55	53	.43	.0023	.0134	.25	.026	.0000	.57	67	34
November, .	4,917,000	[illegible]	60	.50	.0018	.0106	.21	.026	.0000	.46	78	16
Average, .	4,901,000	64	65	.31	.0017	.0106	.23	.030	.0004	.34	45	44

Filter No. 63.

This continuous filter, 20 inches in diameter, was started Sept. 2, 1893, and contained 24 inches in depth of sand of an effective size of 0.16 millimeter. The sand used in this filter was a white, sharp, pure quartz sand, from Berkshire County, such as is used in the manufacture of glass. The history of the filter during 1895 was published in the annual report of the Board, and the points in connection with the operation of the filter during 1896 which are of special importance are described in the following paragraphs.

After draining, the filter went out of operation Nov. 24, 1895. The surface was spaded 4 inches deep on May 7, 1896, and enough new Berkshire sand added to make the bed of sand 24 inches deep; city water was then applied from below. After the surface became covered the filter was allowed to stand for sixteen hours. Canal water was applied May 8, and the filter put into operation at a rate of 5,000,000 gallons per acre daily. This rate was reduced to 3,000,000 gallons on June 1. A short trap attached to the outlet prevented air from entering at the bottom.

On account of low water in the canal the outlet of the filter was closed on the following dates for periods varying from two to twenty-four hours: May 16, 22, 23, 30, June 27, July 11, August 9, 11, September 12, 19, 26, October 17, November 7. The gate was

closed for a longer period of sixty-two hours on September 5, 6, 7. During all of these periods the surface remained covered with water.

In order to remove clogging the surface was scraped on the following dates: on May 15, 0.21 of an inch of sand was removed; on May 21, 0.29 of an inch; on May 26, 0.20 of an inch; on June 17, 0.25 of an inch; on June 23, 0.22 of an inch; on June 30, 0.25 of an inch; on July 6, 0.28 of an inch; on July 15, 0.29 of an inch; on July 22, 0.29 of an inch; on July 28, 0.27 of an inch; on August 3, 0.23 of an inch; on August 14, 0.31 of an inch; on August 22, 0.29 of an inch; on August 31, 0.32 of an inch; on September 10, 0.30 of an inch; on September 24, 0.24 of an inch; on October 5, 0.33 of an inch; on October 14, 0.33 of an inch; on October 26, 0.32 of an inch; on November 3, 0.24 of an inch. After scraping, canal water was applied at once, without raking the surface or filling the filter with city water from below.

A bacteriological analysis of the effluent was made on each day excepting Sundays. The number of bacteria per cubic centimeter found in these samples is given in the record of daily analyses in the following table: —

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 63, 1896.

Day.	May.	June.	July.	August.	September.	October.	November.
1, ...	-	251	21	14	18	27	-
2, ...	-	49	31	-	54	94	54
3, ...	-	37	14	17	54	121	43
4, ...	-	24	-	19	22	-	31
5, ...	-	27	-	35	27	289	18
6, ...	-	29	25	18	-	-	26
7, ...	-	-	16	16	-	90	11
8, ...	8,475	19	23	17	184	67	-
9, ...	1,500	28	18	-	107	73	84
10, ...	-	16	82	76	164	40	67
11, ...	600	24	16	58	89	-	67
12, ...	576	28	-	45	18	22	69
13, ...	290	28	46	45	-	15	52
14, ...	143	-	24	22	39	58	87
15, ...	84	15	34	81	60	51	-
16, ...	71	17	24	-	45	42	-
17, ...	-	29	29	41	38	25	-
18, ...	579	17	22	41	104	-	-
19, ...	123	19	-	25	53	56	-
20, ...	122	17	24	43	-	24	-
21, ...	96	-	29	27	342	40	-
22, ...	56	20	19	18	75	11	-
23, ...	23	15	26	-	198	35	-
24, ...	-	20	16	22	132	41	-
25, ...	93	20	13	88	52	-	-
26, ...	64	10	-	27	40	66	-
27, ...	74	16	36	37	-	70	-
28, ...	158	-	16	20	26	26	-
29, ...	327	29	22	27	55	10	-
30, ...	74	21	27	-	24	-	-
31, ...	-	-	19	15	-	14	-

Monthly Averages of Analyses of Effluent of Filter No. 63.

[Parts per 100,000.]

1896.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F. Applied Water.	Temperature. Deg. F. Effluent.	Chlorine.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
May, . .	4,831,000	62	63	.28	.0009	.0095	.19	.028	.0000	.26	74	63
June, . .	2,762,000	69	[illegible]	.37	[illegible]	.0097	.18	.062	.0000	.38	48	22
July, . .	2,570,000	76	73	.16	.0021	.0100	.29	.028	.0015	.21	20	22
August, . .	2,804,000	77	75	.19	.0011	.0083	.27	.031	.0000	.24	19	11
September, .	2,868,000	65	66	.21	.0025	.0109	.25	.034	.0000	.27	52	47
October, . .	2,787,000	55	54	.36	.0020	.0154	.25	[illegible]	[illegible]	.56	68	65
November, .	2,832,000	45	51	.50	[illegible]	.0120	.21	.025	[illegible]	.45	77	25
Average, .	3,116,000	64	64	.30	.0018	.0105	.23	.028	.0003	.34	51	35

Filter No. 64.

This continuous filter, 20 inches in diameter, was started Sept. 2, 1895, and contained 12 inches in depth of sand of an effective size of 0.16 millimeter. The sand used in this filter was also a white, sharp, pure quartz sand, from Berkshire County. The history of the filter during 1895 was published in the annual report of the Board, and the points in connection with the operation of the filter during 1896 which are of special importance are described in the following paragraphs.

After draining, the filter went out of operation Nov. 24, 1895. The surface was spaded four inches deep on May 7, 1896, and enough new Berkshire sand added to make the bed of sand 12 inches deep. City water was applied on May 8 and the filter put into operation at a prescribed rate of 5,000,000 gallons per acre daily. The depth of water on the surface at this time was 6 inches. A short trap attached to the outlet prevented air from entering the filter at the bottom. June 1 the rate was reduced to 3,000,000 gallons per acre daily. In order to keep the filter running at the required rate, the surface had to be scraped about once in 5 days from July 8 to July 27.

On account of low water in the canal the gate on the outlet was closed on the following dates for periods varying from two to forty-two hours: May 16, 22, 23, 30, June 27, July 11, August 9, 11,

September 12, 19, 26, October 17, November 7. The gate was closed for a longer period of sixty-two hours on September 5, 6, 7. During all of these periods the surface remained covered with water.

In order to remove clogging the surface was scraped on the following dates: May 12, 0.26 of an inch of sand was removed; May 15, 0.22 of an inch; May 20, 0.18 of an inch; May 23, 0.23 of an inch; May 27, 0.20 of an inch; June 2, 0.24 of an inch; June 8, 0.23 of an inch; June 15, 0.26 of an inch; June 22, 0.14 of an inch; June 27, 0.19 of an inch; July 3, 0.20 of an inch; July 9, 0.27 of an inch; July 16, 0.24 of an inch; July 22, 0.25 of an inch; July 27, 0.23 of an inch; July 31, 0.23 of an inch; August 5, 0.20 of an inch; August 13, 0.27 of an inch; August 19, 0.27 of an inch; August 26, 0.30 of an inch; September 1, 0.21 of an inch; September 9, 0.25 of an inch; September 16, 0.30 of an inch; September 24, 0.24 of an inch; October 3, 0.24 of an inch; October 9, 0.23 of an inch; October 15, 0.24 of an inch; October 21, 0.22 of an inch; October 27, 0.23 of an inch; November 2, 0.23 of an inch. After scraping, the surface was not raked, and canal water was applied at once, without filling with city water from below.

A bacteriological analysis was made of a sample of effluent on each day excepting Sundays. The number of bacteria per cubic centimeter found in these samples is given in the record of daily analyses in the following table:—

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No 64, 1896.

Day.	May.	June.	July.	August.	September.	October.	November.
1,	-	761	81	54	23	136	-
2,	-	151	17	-	172	144	953
3,	-	71	22	28	288	344	1,597
4,	-	54	-	476	194	-	1,065
5,	-	46	-	57	240	525	1,290
6,	-	34	17	35	-	214	906
7,	-	-	46	28	-	271	1,500
8,	4,150	42	25	23	698	127	-
9,	1,000	49	122	-	1,118	285	3,328
10,	-	41	66	462	154	152	1,582
11,	1,100	66	50	71	57	-	2,340
12,	1,193	30	-	55	83	49	3,500

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 64, 1896 — Concluded.

Day.	May.	June.	July.	August.	September.	October.	November.
13,	606	20	[illegible]	[illegible]	–	73	4,600
14,	275	–	87	[illegible]	96	74	4,100
15,	280	32	150	[illegible]	672	143	–
16,	79	23	89	–	329	88	–
17,	–	2,108	47	19	362	104	–
18,	978	18	76	[illegible]	274	–	–
19,	215	28	–	28	166	122	–
20,	238	15	46	32	–	[illegible]	–
21,	547	–	53	62	1,757	174	–
22,	127	35	63	17	248	106	–
23,	56	27	12	–	204	81	–
24,	–	20	24	21	167	86	–
25,	316	19	15	24	164	–	–
26,	66	25	–	79	[illegible]	102	–
27,	262	[illegible]	[illegible]	120	–	146	–
28,	957	–	15	65	199	136	–
29,	780	101	68	151	60	82	–
30,	219	28	40	–	109	–	–
31,	–	–	116	18	–	[illegible]	–

Monthly Averages of Analyses of Effluent of Filter No. 64.

[Parts per 100,000.]

1896.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water	Effluent.		Free	Albuminoid.		Nitrates.	Nitrites.			
May,	4,542,000	62	63	.29	.0018	.0115	.19	.023	.0000	.27	71	131
June,	2,711,000	69	69	.37	.0023	.0125	.18	.033	[illegible]	.38	49	29
July,	2,836,000	76	74	.18	.0014	.0090	.28	.034	.0001	.32	25	21
August,	2,809,000	77	75	.20	.0017	.0084	.28	.032	[illegible]	.26	39	15
September,	2,754,000	65	66	.22	.0021	.0108	.25	.035	[illegible]	.25	55	[illegible]
October,	2,821,000	55	56	.43	.0023	.0150	[illegible]	.024	.0000	.58	69	113
November,	2,818,000	45	50	.52	.0058	.0174	.21	.021	.0000	.53	87	906
Average,	3,042,000	64	65	.32	.0025	.0122	.23	.029	.0001	.36	56	193

Water Applied to Filters Nos. 68 and 69.

The water applied to filters Nos. 68 and 69 was polluted in a much greater degree than the Merrimack River water applied to the other experimental filters, as described in the following paragraph.

From May 18 to August 20 a small stream of sewage and a stream of Merrimack River water were allowed to flow simultaneously into the top of a tank from the bottom of which the water applied to filters Nos. 68 and 69 was being drawn. After August 21, however, the mixed sewage and canal water was allowed to stand for several hours before being turned upon the filters. From June 17 to 24 no sewage was mixed with the canal water.

The character of the water applied to filters Nos. 68 and 69 is shown in the table of chemical analyses on page 559.

Bacteriological analyses have been made on each day, excepting Sundays, of at least three and sometimes four samples of the water collected at different hours. The average number of bacteria per cubic centimeter found in these samples is given in the record of daily analyses in the following table: —

Average Daily Number of Bacteria per Cubic Centimeter in Water applied to Filters Nos. 68 and 69, 1896.

Day.	May.	June.	July.	August.	September.	October.	November.	December.
1, ...	-	763,000	799,000	2,200	128,000	192,000	-	146,000
2, ...	-	83,000	1,778,000	-	236,000	148,000	274,000	183,000
3, ...	-	155,000	161,000	8,300	388,000	95,000	240,000	173,000
4, ...	-	654,000	-	2,200	526,000	-	193,000	106,000
5, ...	-	117,000	-	18,000	196,000	102,000	271,000	75,000
6, ...	-	115,000	2,700	15,000	-	86,000	157,000	-
7, ...	-	-	28,000	27,000	-	86,000	234,000	163,000
8, ...	-	161,000	48,000	1,378,000	170,000	63,000	-	134,000
9, ...	-	119,000	662,000	-	286,000	126,000	156,000	162,000
10, ...	-	262,000	1,237,000	41,000	399,000	123,000	145,000	147,000
11, ...	-	198,000	86,000	52,000	267,000	-	132,000	171,000
12, ...	-	664,000	-	6,000	151,000	140,000	145,000	112,000
13, ...	-	103,000	17,000	460,000	-	134,000	131,000	-
14, ...	-	-	9,000	16,000	49,000	132,000	61,000	153,000
15, ...	-	96,000	403,000	15,000	113,000	122,000	-	147,000
16, ...	-	85,000	103,000	-	109,000	96,000	127,000	154,000

Average Daily Number of Bacteria per Cubic Centimeter in Water applied to Filters Nos. 68 and 69, 1896 — Concluded.

Day.	May.	June.	July.	August.	September.	October.	November.	December.
17, ...	-	113,000	15,000	9,500	220,000	110,000	176,000	134,000
18, ...	-	19,000	38,000	[redacted]	174,000	-	111,000	116,000
19, ...	-	19,000	-	15,000	[redacted]	148,000	141,000	183,000
[redacted]	-	11,000	4,300	67,000	-	[redacted]	144,000	-
21, ...	-	-	80,000	19,000	83,000	216,000	118,000	150,000
22, ...	-	12,000	295,000	540,000	178,000	222,000	-	155,000
23, ...	-	11,000	16,000	-	133,000	250,000	167,000	162,000
24, ...	-	23,000	277,000	776,000	144,000	[redacted]	116,000	151, 600
25, ...	-	[redacted]	6,000	266,000	91,000	-	218,000	-
26, ...	-	84,000	-	238,000	56,000	126,000	-	[redacted]
27, ...	-	7,500	14,000	284,000	-	[redacted]	122,000	-
28, ...	211,000	-	22,000	863,000	72,000	190,000	205,000	166,000
29, ...	320,000	66,000	5,500	501,000	111,000	119,000	-	120,000
30, ...	83,000	38,000	5,695,000	-	102,000	311,000	126,000	135,000
31, ...	-	-	1,500	297,000	-	219,000	-	165,000

Average of Chemical Analyses of Water applied to Filters Nos. 68 and 69.

1896.	Temperature. Deg. F.	Color.	Ammonia. Free	Ammonia. Albuminoid. Total	Ammonia. Albuminoid. Soluble.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
June, ...	66	.50	.1653	.0243	–	.70	.014	.0001	.42	68,[redacted]
July, ...	75	.34	.0118	.0189	–	.28	.029	.0001	.25	8,000
August, ...	76	.39	.2301	.0442	–	.71	.020	.0001	.37	515,000
September, ...	63	.45	.2215	.0505	.0406	.79	.043	.0020	.44	[redacted],000
October, ...	55	.53	.2000	.0540	.0400	.69	.020	.0030	.46	133,000
November, ...	55	.54	.2700	[redacted]	.0420	.65	.023	.0016	.53	137,000
December, ...	43	.51	.2720	[redacted]	.0444	.64	.026	[redacted]	.51	155,000
Average, ...	62	.47	.1958	.0432	.0417	.64	.025	.0014	.46	156,000

Filter No. 68.

This continuous filter, 20 inches in diameter, was started on May 18, 1896, and contained 5 feet in depth of sand of an effective size of 0.23 millimeter. The points in connection with the construction and operation of this filter which are of special importance are described in the following paragraphs.

The underdrains in this filter are 6 inches deep, and are constructed as usual. Above these underdrains 5 feet of sand, obtained in the neighborhood of Lawrence, were put into the filter dry. A short trap attached to the outlet prevented air from entering the filter at the bottom. City water was applied slowly from below on May 18 and as soon as the water covered the surface the gate on the outlet was closed and the filter allowed to stand inoperative for eighteen hours. The filter was put into operation on May 19, at a prescribed rate of 5,000,000 gallons per acre daily, and the character of the water applied is shown in the table of chemical analyses. The rate of filtration was reduced on May 25 to 2,500,000, and on August 2 to 1,000,000, gallons per acre daily.

On account of low water in the canal the gate on the outlet was closed on the following dates for periods varying from two to forty-three hours: May 23, 30, June 27, July 11, 15, August 9, 11, September 12, 19, 26, October 17, November 7, 14, 21. The gate was closed for a longer period of sixty-two hours on September 5, 6, 7. During all of these periods the surface remained covered with water. In order to remove clogging the surface was scraped on the following dates: June 3, 0.49 of an inch of sand was removed; June 15, 0.45 of an inch; June 26, 0.30 of an inch; July 9, 0.38 of an inch; July 22, 0.36 of an inch; August 5, 0.29 of an inch; October 12, 0.36 of an inch; November 2, 0.45 of an inch; November 25, 0.39 of an inch; December 7, 0.32 of an inch; December 21, 0.34 of an inch. After scraping, the surface was not raked, and the applied water was turned on at once, without filling with city water from below.

B. prodigiosus mixture was applied to Filter No. 68, in the proportion of one part of mixture to 170,000 parts of applied water, during November and December.

Bacteriological analyses were made on each day excepting on Sunday of two samples of effluent; one of these samples was collected in the forenoon and the other in the afternoon. The average

number of bacteria per cubic centimeter found in each set of two samples is given in the record of daily analyses in the following table: —

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 68, 1896.

Day.	May.	June.	July.	August.	September.	October.	November. Water Bacteria.	November. B. Prodigiosus.	December. Water Bacteria.	December. B. Prodigiosus.
1, ...	-	397,000	253,000	1,200	1,950	4,300	-	-	3,300	0
2, ...	-	304,000	498,000	-	600	5,600	20,000	0	4,000	0
3, ...	-	244,000	469,000	450	1,500	3,200	9,400	0	2,400	0
4, ...	-	511,000	-	750	7,700	-	3,100	0	2,500	0
5, ...	-	146,000	-	2,300	3,900	3,100	4,800	0	1,600	0
6, ...	-	-	12,000	2,500	-	4,900	6,700	0	-	-
7, ...	-	-	5,300	1,300	-	2,700	5,200	0	4,800	0
8, ...	-	139,000	3,800	-	32,000	2,600	-	-	1,400	0
9, ...	-	251,000	36,000	-	20,000	1,800	5,200	0	700	0
10, ...	-	332,000	26,000	1,600	19,000	2,100	7,500	0	1,700	0
11, ...	-	187,000	37,000	1,400	13,000	-	5,000	50	8,200	150
12, ...	-	192,000	-	812	11,000	5,500	5,600	150	4,400	0
13, ...	-	17,000	16,000	2,700	-	8,900	4,800	0	-	-
14, ...	-	-	2,600	71,000	11,000	3,400	5,000	0	780	0
15, ...	-	99,000	15,000	2,000	6,500	5,800	-	-	1,169	0
16, ...	-	10,000	4,200	-	5,900	4,500	2,800	200	1,084	0
17, ...	-	45,000	2,300	33,000	4,400	3,100	5,700	0	726	0
18, ...	-	24,000	4,500	17,500	4,800	-	10,600	0	1,400	0
19, ...	21,000	23,000	-	2,500	4,000	1,700	3,700	0	218	0
20, ...	124,000	18,000	1,050	2,500	-	1,500	4,900	0	-	-
21, ...	69,000	-	5,600	17,900	-	4,900	4,700	0	1,400	0
22, ...	58,000	127,000	17,000	208,000	7,900	7,700	-	-	900	0
23, ...	263,000	4,300	5,800	-	4,500	7,100	6,700	50	400	0
24, ...	-	4,200	4,800	31,000	6,400	1,300	7,100	150	1,100	0
25, ...	479,000	34,000	3,500	34,000	7,500	-	5,000	0	-	-
26, ...	329,000	108,000	-	15,000	6,500	3,600	-	-	1,600	0
27, ...	224,000	7,400	14,000	14,000	-	5,700	1,500	50	-	-
28, ...	135,000	-	3,400	20,000	3,200	6,700	13,000	50	4,200	0
29, ...	179,000	7,500	2,700	23,000	4,600	3,100	-	-	4,500	0
30, ...	-	8,600	3,700	-	4,100	-	7,300	0	3,600	0
31, ...	-	-	1,500	1,100	-	12,000	-	-	1,200	0

Monthly Averages of Analyses of Effluent of Filter No. 68.

[Parts per 100,000.]

1896.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F. Applied Water.	Temperature. Deg. F. Effluent.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
May, . .	3,745,000	54	60	.24	.2300	.0400	.31	.088	.0000	.22	1.0	466,000
June, . .	1,707,000	70	64	.34	.2260	.0440	.37	.101	.0021	.34	0.6	238,000
July, . .	2,574,000	77	76	.21	.0470	.0119	.31	.035	.0041	.18	36.5	2,400
August, . .	1,964,000	77	76	.24	.0290	.0230	.72	.019	.0018	.26	5.7	19,800
September, .	1,005,000	66	60	.23	.1680	.0285	.80	.067	.0022	.26	14.8	7,400
October, . .	1,086,000	65	62	.37	.1940	.0285	.79	.022	.0080	.38	2.9	–
November, .	1,058,000	55	51	.62	.2250	.0290	.66	.005	.0002	.53	2.2	11,800
December, .	1,041,000	48	46	.45	.2140	.0289	.69	.018	.0001	.42	5.7	2,200
Average, .	1,756,000	62	61	.40	.1666	.0292	.64	.043	.0016	.32	8.7	121,000

Filter No. 69.

This intermittent filter, 20 inches in diameter, was started on May 18, 1896, and contained 5 feet in depth of sand of an effective size of 0.23 millimeter. The points in connection with the operation of this filter which were of special importance are described in the following paragraphs.

The filter was a duplicate of Filter No. 68. The sand was put into the filter dry, city water was applied slowly from below on May 18 until the surface of the sand became covered, and the gate on the outlet was then closed for sixteen hours. On May 19 Filter No. 69 went into operation as an intermittent filter, at a prescribed rate of 5,000,000 gallons per acre daily. The period of intermittent operation was arranged in such a manner that the surface became and remained uncovered for two hours during the day. The rate of filtration was reduced on May 25 to 2,500,000 gallons per acre daily, and on August 20 to 1,000,000 gallons. A short trap attached to the outlet prevented air from entering the filter at the bottom.

Owing to low water in the canal the gate on the outlet was closed on the following dates for periods varying from two to forty-two hours: May 23, 30, June 27, July 11, August 9, 10, 11, September 12, 19, 26, October 17, November 7, 14, 21. The gate was closed for a longer period of sixty-three hours on September 5, 6, 7. During all of these periods the surface remained covered with water.

In order to remove clogging the surface was scraped on the following dates: May 27, 0.29 of an inch of sand was removed; June 4, 0.48 of an inch; June 8, 0.26 of an inch; June 11, 0.30 of an

inch; June 15, 0.29 of an inch; June 18, 0.29 of an inch; June 26, 0.25 of an inch; July 2, 0.26 of an inch; July 9, 0.31 of an inch; July 21, 0.28 of an inch; July 28, 0.24 of an inch; August 15, 0.31 of an inch; August 31, 0.27 of an inch; September 4, 0.22 of an inch; October 15, 0 35 of an inch; October 27, 0.44 of an inch; November 18, 0.30 of an inch; November 27, 0.34 of an inch; December 5, 0.39 of an inch; December 11, 0.25 of an inch; December 17, 0.32 of an inch; December 28, 0.23 of an inch. On September 4 the surface was spaded to a depth of 2 inches after scraping; but on other occasions the applied water was turned on at once, without raking the surface or filling from below with city water.

B. prodigiosus mixture was applied to this filter, during November and December, in the proportion of one part of mixture to 170,000 parts of applied water.

Bacteriological analyses were made on each day excepting on Sunday of two samples of effluent; one of these samples was collected in the forenoon and the other in the afternoon. The average number of bacteria per cubic centimeter found in each set of two samples is given in the record of daily analyses in the following table: —

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 69, 1896.

Day.	May.	June.	July.	August.	September.	October.	November.		December.	
							Water Bacteria	B Prodigiosus.	Water Bacteria.	B. Prodigiosus.
1, ...	-	10,900	1,700	1,000	5,100	400	-	-	179	1
2, ...	-	14,000	159,000	-	700	200	345	0	163	2
3, ...	-	12,000	456,000	300	500	100	926	0	43	2
4, ...	-	223,000	-	3,600	2,100	-	181	0	91	0
5, ...	-	66,000	-	350	1,500	6,200	1,778	0	91	0
6, ...	-	-	850	1,100	-	2,700	5,942	0	-	-
7, ...	-	-	1,000	750	-	800	488	0	335	0
8, ...	-	32,000	1,100	400	13,600	2,100	-	-	255	2
9, ...	-	151,000	49,000	-	11,200	800	2,400	2	77	0
10, ...	-	3,500	22,000	299	4,800	500	4,700	12	63	0
11, ...	-	27,000	5,000	5,600	2,800	-	520	1	139	0
12, ...	-	119,000	-	4,300	1,900	800	500	0	49	0
13, ...	-	93,000	5,100	2,400	-	300	250	0	-	-

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 69, 1896 — Concluded

Day.	May.	June.	July.	August.	September.	October.	November. Water Bacteria.	November. B. Prodigiosus.	December. Water Bacteria.	December. B. Prodigiosus.
14,	-	-	550	5,000	1,900	200	200	0	716	0
15,	-	171,000	4,700	600	2,700	300	-	-	40	0
16,	-	43,000	960	-	800	1,600	[illegible]	0	71	0
17,	-	8,400	5,500	900	600	200	450	0	129	0
18,	-	6,700	1,560	280	1,100	-	200	0	578	0
19,	9,000	3,700	-	2,700	400	[illegible]	2,000	0	101	0
20,	131,000	2,000	250	[illegible]	-	360	391	0	-	-
21,	114,000	-	1,600	1,900	800	170	365	1	346	0
22,	119,000	900	62,800	800	2,100	390	-	-	182	0
[illegible]	130,000	418	4,800	-	1,400	130	-	-	99	0
24,	-	561	3,200	5,200	1,100	170	878	0	99	0
25,	118,000	1,800	1,700	1,700	3,600	-	1,400	7	-	-
26,	65,000	2,400	-	[illegible]	400	228	-	-	44	0
27,	7,000	1,600	1,100	1,800	-	198	1,626	2	-	-
28,	16,000	-	2,600	1,700	2,500	458	416	[illegible]	70	0
29,	30,000	3,400	950	800	2,400	510	-	-	396	0
30,	-	7,900	3,700	-	300	226	[illegible]	0	157	0
31,	-	-	600	3,600	-	170	-	-	100	0

Monthly Averages of Analyses of Effluent of Filter No. 69.

[Parts per 100,000.]

[illegible]	Quantity of Effluent — Gallons per Acre Daily.	Temperature Deg. F. Applied Water.	Temperature Deg. F. Effluent.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Per Cent of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
May,	3,773,000	64	69	.23	.4000	.0880	.85	.096	.0006	.17	26	115,000
June,	2,276,000	70	68	.26	.2027	.0320	.77	.116	.0049	.23	21	19,900
July,	2,323,000	77	76	.17	.0023	.0099	.31	.031	.0000	.19	44	650
August,	1,955,000	77	76	.14	.0467	.0141	.77	.185	.0075	.19	44	2,950
September,	1,124,000	66	61	.19	.0567	.0168	.61	.121	.0000	.23	26	1,300
October,	997,000	65	55	.26	.0066	.0121	.66	.161	.0000	.26	62	1,200
November,	1,076,000	55	51	.34	.0094	.0119	.66	.262	.0000	.31	60	8,800
December,	1,123,000	43	47	[illegible]	.0046	.0117	.63	.208	.0001	.26	59	257
Average,	1,831,000	65	61	.25	.0686	.0183	.64	.147	.0016	.25	43	18,170

Water Applied to Filter No. 79.

The effluent from filters Nos. 68 and 69 was applied to Filter No. 79, and a bacteriological analysis was made on each day, excepting Sundays, of a sample of the water. The number of bacteria per cubic centimeter found in these samples is given in the following table: —

Average Daily Number of Bacteria per Cubic Centimeter in the Water Applied to Filter No. 79, 1896.

Day.	September.	October.	November.	December.
1,	-	4,800	-	8,400
2,	-	16,000	27,000	4,300
3,	-	14,000	36,000	4,900
4,	-	-	12,000	6,300
5,	-	13,000	12,000	2,800
6,	-	20,000	16,000	-
7,	-	8,000	20,000	-
8,	-	12,000	-	1,500
9,	-	4,800	73,000	3,600
10,	-	7,200	15,000	2,800
11,	-	-	14,000	7,700
12,	-	5,100	16,000	9,500
13,	-	6,300	10,000	-
14,	-	23,300	9,000	1,900
15,	-	8,000	-	-
16,	-	4,400	39,000	1,000
17,	-	5,300	81,000	1,900
18,	-	-	62,000	1,700
19,	-	8,900	57,000	1,700
20,	-	5,300	18,000	-
21,	-	6,200	-	-
22,	-	11,300	-	5,300
23,	-	12,000	-	2,400
24,	7,000	9,900	-	2,800
25,	7,800	-	8,200	-
26,	7,300	7,300	-	3,600
27,	-	7,100	13,000	-
28,	21,000	5,100	17,000	2,100
29,	9,000	5,400	-	1,600
30,	8,400	5,400	6,200	1,800
31,	-	-	-	1,100

Filter No. 79.

This continuous filter was started on Sept. 18, 1896, and contained 5 feet in depth of sand of an effective size of 0.23 millimeter. The sand was put into the filter dry and city water applied below until the surface of the sand became covered with water. The gate on the outlet was then closed and the filter allowed to stand for twenty-four hours. On September 18 the filter went into operation at a prescribed rate of 3,300,000 gallons per acre daily. The water applied to this filter was a mixture of the effluents from filters Nos. 68 and 69. On November 23 18 inches of sand were removed from the top of Filter No. 79, and two sets of cleats were nailed to the inner sides of the walls. One set of cleats was fastened to the walls 18 inches below the level of the original surface of the sand, and the other set 12 inches below. The cleats were made with bevelled edges, which sloped towards the walls and projected one-quarter of an inch from the wood to which they were fastened, and by this arrangement formed pockets into which the sand settled and made a close joint between the walls of the filter and the bed of sand. As soon as the cleats had been put into position the sand which had been taken out was replaced. On November 24 city water was applied from below until the surface became covered with water. The gate on the outlet was then closed and the filter allowed to stand for twenty-four hours. When the filter went into operation again, on November 25, canal water instead of the effluents from filters Nos. 68 and 69 was applied. After filtering canal water for two weeks, the effluents from filters Nos. 68 and 69 were turned on again on December 7. The rate of filtration was increased to 4,700,000 gallons per acre daily on December 14.

Owing to low water in the canal the gate on the outlet was closed for periods varying from thirty-nine to forty-three hours on the following dates: September 19, 26, October 17, November 7, 14. During all of these periods the surface remained covered with water. In order to remove clogging the surface was scraped on the following dates: December 21, 0.37 of an inch of sand was removed; December 27, 0.36 of an inch was removed. After scraping, the applied water was turned on at once.

B. prodigiosus mixture was applied to this filter from October 25 to November 30, in the proportion of one part to 170,000 parts of applied water.

A bacteriological analysis was made on each day excepting on Sunday of a sample of the effluent from Filter No. 79. The average number of bacteria per cubic centimeter found in each of these analyses is given in the following table:—

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 79, 1896.

Day.	September.	October. Water Bacteria.	October. B. Prodigiosus.	November. Water Bacteria.	November. B. Prodigiosus.	December.
1,	-	35,000	-	-	-	600
2,	-	26,000	-	12,000	0	200
3,	-	74,000	-	9,000	0	100
4,	-	-	-	7,200	0	600
5,	-	22,000	-	5,100	0	300
6,	-	41,000	-	8,400	0	-
7,	-	17,000	-	12,000	0	1,100
8,	-	-	-	-	-	700
9,	-	12,000	-	16,000	0	900
10,	-	8,400	-	6,800	0	1,200
11,	-	-	-	5,900	0	700
12,	-	14,000	-	9,600	0	157
13,	-	6,600	-	5,200	400	-
14,	-	25,000	-	2,300	0	712
15,	-	12,000	-	-	-	340
16,	-	13,000	-	7,800	0	344
17,	-	5,700	-	4,900	0	271
18,	-	-	-	2,700	0	316
19,	-	19,000	-	3,400	0	214
20,	-	6,700	-	1,700	0	-
21,	-	8,800	-	-	-	625
22,	-	5,700	-	-	-	500
23,	-	3,800	-	-	-	400
24,	-	5,900	-	-	-	200
25,	23,000	-	-	9,100	0	-
26,	39,000	4,000	100	9,000	400	134
27,	-	4,900	0	4,000	100	-
28,	38,000	6,800	0	4,000	100	394
29,	28,000	4,400	0	-	-	344
30,	30,000	9,000	0	5,000	100	560
31,	-	-	-	-	-	226

Monthly Averages of Analyses of Effluent of Filter No. 79.

[Parts per 100,000.]

1896.	Quantity of Effluent. Gallons per Acre Daily.	Temperature Deg. F. Applied Water	Temperature Deg. F. Effluent	Color.	Ammonia. Free	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Per Cent of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
September,	1,053,000	61	53	.15	.0500	.0180	.65	.093	.0080	.36	93	74,000
October,	929,000	54	52	.24	.0228	.0150	.76	.131	.0016	.31	42	18,700
November,	845,000	51	51	.47	.0157	.0151	.67	.187	.0007	.42	52	7,600
December,	1,215,000	47	48	.36	[illegible]	.0131	[illegible]	.136	.0005	.38	51	356
Average,	1,011,000	53	51	.31	.0237	.0153	.66	.137	.0027	.37	59	25,164

Lawrence City Filter.

The filter of the water supply system of the city of Lawrence is 2.5 acres in area, was first put into operation Sept. 20, 1893, and its construction and action were described in the report of the State Board of Health for that year. From the date of starting this filter up to the present time it has been in continuous use, and not once has the unfiltered river water entered the reservoir or the service pipes of the city water supply. The filter is still uncovered, and hence unprotected from the severe cold of the winters of the climate of Lawrence. As a result of this, a thick coating of ice forms upon the filter and has to be removed to enable the surface to be scraped. The surface is very much disturbed by the removal of the ice, and the bacterial efficiency of the filter is not, at times, as good as it otherwise would be.

The effect of this filter upon the health of the people of Lawrence is well shown by the following table, giving the deaths from typhoid fever in the city during the period 1885 to 1896 inclusive. Many of the deaths are of operatives in the mills which are piped with the unfiltered river water.

Deaths from Typhoid Fever in Lawrence, 1885-96.

Years.	Total Number of Deaths.	Deaths per 10,000 of Population.	Persons who may have been exposed to Infection — By Drinking Canal Water.	Persons who may have been exposed to Infection — While Living out of Town just before falling Sick in Lawrence.
1885,	17	4.20	-	-
1886,	23	5.75	-	-
1887,	47	11.75	-	-
1888,	48	12.00	-	-
1889,	55	13.75	-	-
1890,	60	13.33	-	-
1891,	55	12.20	-	-
1892,	50	11.11	-	-
1893,	39	8.66	-	-
1894,	24	5.00	12	4
1895,	16	3.07	9	2
1896,	10	1.86	2	4

The daily bacterial determinations made during the winter of 1895–96 were given in the last report. During the summer of 1896 bacterial determinations were made once each week, and from Dec. 1, 1896, to April 30, 1897, daily, except Sundays and on a few other occasions. All the determinations made are given in the tables.

The bacteria found in the filtered water at the different points occasionally numbered more than 100 per cubic centimeter. These high numbers were partly due to the following causes: —

From May 14 to June 1 a species of bacillus which was common in the air appeared in the water at the outlet of the reservoir in considerable numbers. The bacillus was found in the tap water at the city hall after May 20, and in the tap water at the experiment station after May 24. During the last week in May the filter was scraped, spaded 10 inches deep and restored to its original level with washed sand. During the week which preceded July 20 repairs were made in the force main leading from the pumping station to the reservoir. During this period the sediment which had collected within the main at certain places was scraped off and passed into the reservoir. From August 10 to 22 engineers made a series of tests on the pumps at the station and on the water main. The force main leading from the pumps to the reservoir was tapped at several places and gauges were attached. The water was drawn out of the main and its interior partially scraped, and finally a weir was constructed about the overflow of the force main in the reservoir, to measure the volume of water pumped. About September 1 the floor in the station at one side of the pump well was torn up, in order to build the foundation for a new pump, and a pipe was laid from the pump into the well. While these changes were being made, foreign matter of various kinds was washed into the filtered water in the pump well and pumped up into the reservoir. This work of construction lasted until November 30.

The high number of bacteria in the tap water at the experiment station on October 30 was due to dirt which washed into the pipe during repairs in the water main.

Number of Bacteria per Cubic Centimeter in the Lawrence City Water before and after Filtration.

DATE — 1896.	In the Merrimack River Water.	IN FILTERED WATER FROM			Tap at the Experiment Station.
		City Filter.	Reservoir Outlet.	Tap at City Hall.	
May 4,	1,300	22	23	12	10
11,	1,650	29	7	7	10
18,	2,000	17	291	53	55
25,	11,000	142	90	65	43
June 1,	9,100	166	290	197	103
8,	10,700	95	163	111	89
15,	12,300	23	35	19	15
22,	12,000	13	41	16	17
29,	3,600	31	37	62	43
July 6,	3,400	70	34	87	55
13,	6,200	34	11	198	71
20,	2,000	12	344	146	112
28,	2,200	22	98	62	31
Aug. 3,	2,200	29	66	83	55
10,	3,800	784	336	157	99
17,	2,600	376	180	91	82
24,	6,300	81	139	115	72
31,	3,400	33	206	137	66
Sept. 5,	13,700	32	222	122	63
9,	24,000	30	238	107	60
14,	9,200	50	104	107	62
22,	18,000	32	75	63	42
28,	9,700	30	53	118	40
Oct. 6,	13,000	31	167	35	55
13,	13,000	16	78	35	43
19,	5,300	30	64	40	40
26,	9,100	44	48	45	150
Nov. 2,	6,600	42	72	55	31
9,	6,500	63	147	52	38
16,	4,300	45	57	27	29
25,	6,100	58	60	30	28
30,	6,000	25	21	30	60
Averages,	7,523	78	119	78	55

Daily Bacterial Results, Lawrence City Water.

[Bacteria per Cubic Centimeter.]

Date — 1896.	In River Water.	In Filtered Water from				Condition of Surface when Pumps were Stopped.	Loss of Head.
		City Filter.	Reservoir Outlet.	Tap at City Hall.	Tap at Experiment Station.		Feet.
December 1, . . .	4,700	109	[illegible]	33	[illegible]	Covered.	4.8
2, . . .	5,100	42	48	30	38	Covered.	4.7
3, . . .	9,200	26	36	58	40	Drained.	6.6
4, . . .	8,800	21	25	5	54	Covered.	6.7
5, . . .	7,900	41	41	39	29	Covered.	6.7
6, . . .	–	–	–	–	–	–	–
7, . . .	7,000	35	28	24	[illegible]	Covered.	5.5
8, . . .	8,700	49	–	40	19	Covered.	6.4
9, . . .	7,700	34	–	28	17	Covered.	6.1
10, . . .	12,000	43	–	36	25	Drained.	6.2
11, . . .	–	–	–	–	52	Covered.	6.0
12, . . .	2,200	27	–	25	22	Covered.	6.3
13, . . .	–	–	–	–	–	–	–
14, . . .	–	–	–	–	16	Covered.	6.5
15, . . .	1,000	41	[illegible]	18	31	Covered.	6.2
16, . . .	14,000	60	–	43	15	Covered.	6.3
17, . . .	6,500	190	–	31	34	Covered.	6.9
18, . . .	9,600	48	–	41	17	Drained.	6.1
19, . . .	15,000	106	–	60	27	Covered.	7.1
20, . . .	–	–	–	–	–	–	–
21, . . .	16,000	56	–	64	71	Covered.	5.7
22, . . .	11,000	74	–	82	54	Covered.	6.0
23, . . .	14,000	65	–	145	49	Covered.	6.9
24, . . .	14,000	123	–	58	35	Covered.	6.7
25, . . .	–	–	–	–	–	Covered.	6.6
26, . . .	13,000	21	–	55	26	Covered.	5.3
27, . . .	–	–	–	–	–	–	–
28, . . .	18,000	122	225	216	85	Covered.	5.4
29, . . .	19,000	52	–	104	90	Covered.	6.1
30, . . .	6,300	90	–	74	[illegible]	Covered.	6.4
31, . . .	9,700	71	–	144	87	Drained.	6.6

Daily Bacterial Results, Lawrence City Water.

[Bacteria per Cubic Centimeter.]

Date — 1897.	In River Water.	In Filtered Water from				Condition of Surface when Pumps were Stopped.	Loss of Head.
		City Filter.	Reservoir Outlet.	Tap at City Hall.	Tap at Experiment Station.		Feet.
January 1,	10,000	45	–	56	55	[illegible]	7.4
2,	15,000	71	–	77	36	Covered.	7.8
3,	–	–	–	–	–	–	–
4,	8,500	173	–	88	48	Covered.	6.4
5,	–	–	–	–	47	Drained.	6.8
6,	21,000	86	–	56	47	Drained.	7.4
7,	12,000	94	–	57	43	Covered.	7.3
8,	37,000	119	–	62	46	Drained.	7.5
9,	–	–	–	–	66	Covered.	7.6
10,	–	–	–	–	–	–	–
11,	3,900	31	41	36	[illegible]	Covered.	6.4
12,	10,000	157	–	67	30	Covered.	7.3
13,	13,000	[illegible]	–	33	22	Covered.	7.4
14,	5,600	59	–	32	24	Covered.	7.3
15,	7,100	44	–	30	27	Covered.	6.7
16,	12,000	120	–	35	30	Covered.	7.0
17,	–	–	–	–	–	–	–
18,	9,300	60	90	22	34	Covered.	6.3
19,	8,700	68	–	31	24	Drained.	7.1
20,	6,700	158	–	28	26	Covered.	7.1
21,	5,400	77	–	22	51	Covered.	7.4
22,	15,000	57	–	64	28	Drained.	7.5
23,	16,400	54	–	65	56	Drained.	7.4
24,	–	–	–	–	–	–	–
25,	13,000	[illegible]	67	64	56	Covered.	7.8
26,	12,000	80	–	46	43	Covered.	7.6
27,	17,000	104	–	75	32	Covered.	7.5
28,	–	–	–	–	29	Covered.	7.6
29,	–	–	–	–	44	Covered.	7.5
30,	57,000	46	–	47	39	Covered.	7.5
31,	–	–	–	–	–	–	–

Daily Bacterial Results, Lawrence City Water.

[Bacteria per Cubic Centimeter.]

Date — 1897.	In River Water.	In Filtered Water from				Condition of Surface when Pumps were Stopped.	Loss of Head.
		City Filter.	Reservoir Outlet.	Tap at City Hall.	Tap at Experiment Station.		Feet.
February 1, . . .	17,000	61	63	52	35	Covered.	7.4
2, . . .	11,000	38	-	26	29	Covered.	7.6
3, . . .	17,000	32	-	37	31	Drained.	7.6
4, . . .	18,000	60	-	41	59	Covered.	7.5
5, . . .	9,500	45	-	54	23	Covered.	7.4
6, . . .	14,000	50	-	-	28	Drained.	7.5
7, . . .	-	-	-	-	-	-	-
8, . . .	21,000	125	61	51	44	Covered.	7.5
9, . . .	9,300	142	-	53	44	Drained.	7.4
10, . . .	14,000	102	-	60	44	Drained.	7.6
11, . . .	4,500	44	-	-	47	Drained.	7.4
12, . . .	13,000	42	-	45	68	Covered.	7.4
13, . . .	13,000	60	-	46	54	Covered.	7.4
14, . . .	-	-	-	-	-	-	-
15, . . .	9,700	49	60	49	65	Covered.	7.7
16, . . .	23,000	42	-	47	50	Covered.	7.6
17, . . .	15,000	65	-	-	75	Drained.	7.5
18, . . .	17,000	76	-	38	60	Covered.	7.4
19, . . .	11,800	126	-	44	55	Drained.	7.4
20, . . .	15,000	196	-	42	57	Covered.	7.7
21, . . .	-	-	-	-	-	-	-
22, . . .	-	-	-	-	-	Covered.	7.7
23, . . .	10,000	171	97	47	60	Drained.	7.8
24, . . .	9,800	108	-	80	78	Covered.	7.6
25, . . .	5,000	57	-	48	56	Drained.	7.5
26, . . .	14,200	54	-	-	71	Drained.	7.4
27, . . .	9,800	84	-	65	67	Drained.	7.4
28, . . .	-	-	-	-	-	Covered.	7.7

Daily Bacterial Results, Lawrence City Water.

[Bacteria per Cubic Centimeter.]

Date — 1897.	In River Water.	In Filtered Water from				Condition of Surface when Pumps were Stopped.	Loss of Head.
		City Filter.	Reservoir Outlet.	Tap at City Hall.	Tap at Experiment Station.		Feet.
March 1, . . .	16,000	71	55	56	79	Covered.	6.4
2, . . .	11,200	104	–	62	64	Covered.	7.3
3, . . .	21,600	124	–	60	66	Covered.	7.6
4, . . .	16,600	75	–	80	74	Drained.	7.7
5, . . .	17,300	41	–	61	[illegible]	Drained.	7.6
6, . . .	21,400	42	–	110	58	Drained.	7.7
7, . . .	–	–	–	–	–	–	–
8, . . .	8,300	97	65	71	80	Covered.	7.0
9, . . .	15,700	55	–	56	66	Drained.	7.7
10, . . .	17,100	66	–	64	66	Drained.	7.7
11, . . .	16,300	67	–	42	52	Drained.	7.7
12, . . .	11,100	61	–	47	62	Covered.	7.7
13, . . .	17,600	64	–	70	29	Covered.	7.6
14, . . .	–	–	–	–	–	–	–
15, . . .	11,300	101	68	60	56	Covered.	7.0
16, . . .	18,000	110	–	97	[illegible]	Covered.	7.5
17, . . .	6,700	102	–	45	55	Covered.	7.5
18, . . .	7,200	78	–	98	63	Covered.	7.5
19, . . .	9,000	55	–	52	46	Drained.	7.6
20, . . .	11,400	41	–	62	92	Covered.	7.6
21, . . .	–	–	–	–	–	–	–
22, . . .	14,300	43	60	61	[illegible]	Covered.	7.0
[illegible] . . .	5,300	50	–	141	55	Drained.	7.3
24, . . .	14,200	87	–	[illegible]	66	Drained.	7.5
25, . . .	8,900	45	–	56	[illegible]	Covered.	7.5
26, . . .	7,700	40	–	51	64	Drained.	7.6
27, . . .	5,700	–	–	63	43	Covered.	7.6
28, . . .	–	–	–	–	–	–	–
29, . . .	6,200	37	37	47	63	Covered.	7.4
30, . . .	5,200	29	–	35	40	Drained.	7.6
31, . . .	3,500	28	–	38	48	Drained.	7.5

Daily Bacterial Results, Lawrence City Water.

[Bacteria per Cubic Centimeter.]

Date — 1897.	In River Water.	In Filtered Water from				Condition of Surface when Pumps were Stopped.	Loss of Head.
		City Filter.	Reservoir Outlet.	Tap at City Hall.	Tap at Experiment Station.		Feet.
April 1, ...	4,200	21	-	34	42	Covered.	7.4
2, ...	6,500	46	-	28	35	Covered.	7.2
3, ...	13,300	33	-	46	51	Covered.	7.1
4, ...	-	-	-	-	-	-	-
5, ...	3,600	21	43	45	56	Covered.	7.7
6, ...	6,900	56	-	27	30	Covered.	6.6
7, ...	8,900	38	-	15	43	Drained.	6.4
8, ...	7,000	52	-	68	46	Covered.	6.9
9, ...	11,200	49	-	22	59	Drained.	6.8
10, ...	11,900	25	-	[redacted]	43	Covered.	7.1
11, ...	-	-	-	-	-	-	-
12, ...	4,600	41	-	147	49	Covered.	6.5
13, ...	10,400	65	23	66	52	Drained.	7.3
14, ...	7,200	43	-	34	30	Drained.	7.6
15, ...	4,800	62	-	52	35	Drained.	7.4
16, ...	4,900	81	-	37	37	Covered.	6.7
17, ...	6,600	46	-	82	64	Covered.	6.8
18, ...	-	-	-	-	-	-	-
19, ...	-	-	-	-	-	Covered.	7.2
20, ...	5,500	96	-	-	98	Drained.	7.5
21, ...	3,600	43	[redacted]	93	71	Drained.	7.3
22, ...	8,200	35	-	36	76	Drained.	7.2
23, ...	2,300	58	-	29	28	Covered.	6.9
24, ...	2,800	42	-	66	16	Covered.	6.1
25, ...	-	-	-	-	-	-	-
26, ...	7,200	94	28	58	68	Covered.	6.5
27, ...	5,100	35	-	50	32	Covered.	5.9
28, ...	15,600	20	-	29	39	Drained.	7.2
29, ...	4,800	98	-	36	67	Drained.	7.0
30, ...	3,800	82	-	85	47	Covered.	6.2

Monthly Averages of Bacterial Results from the Lawrence City Water.

Months.	Bacteria per Cubic Centimeter in Water from				
	River.	Effluent at Filter.	Reservoir Outlet.	City Hall Tap.	Experiment Station Tap.
1896.					
May to November, inclusive, ...	7,523	78	119	78	55
December, ...	9,695	67	59	58	42
1897.					
January, ...	13,314	91	73	49	39
February, ...	13,113	79	92	48	52
March, ...	12,065	67	63	62	63
April, ...	6,904	47	39	51	50
Average, ...	10,434	71	74	58	50
Per cent. which the average number of bacteria removed was of the average number of river bacteria, ...	-	99.32	99.29	99.45	99.53

The following tables give the averages of the chemical analyses of the river water and also of the filtered water collected at various points on the water supply system once each week during the year. The bacterial results given in these tables are of these samples only.

Monthly Averages of Analyses of the Merrimack River Water as it flows upon the Lawrence City Filter.

[Parts per 100,000.]

1896.	Temperature. Deg. F.	Color.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Bacteria per Cubic Centimeter.
			Free.	Albuminoid.			Nitrates.	Nitrites.			
				Total.	Soluble.						
January, . . .	33	.42	.0077	.0162	.0150	.18	.022	.0001	.43	1.3	7,800
February, . .	34	.44	.0053	.0174	.0149	.18	.019	.0000	.43	1.4	11,800
March, . . .	35	.40	.0034	.0185	.0129	.15	.012	.0000	.32	1.0	6,500
April, . . .	47	.41	.0027	.0148	.0136	.13	.010	.0000	.34	0.9	2,300
May, . . .	66	.40	.0052	.0217	.0177	.19	.014	.0000	.32	1.2	9,800
June, . . .	62	.51	.0145	.0252	.0194	.21	.012	.0000	.40	1.5	6,400
July, . . .	76	.36	.0152	.0227	.0171	.27	.009	.0001	.26	1.7	3,900
August, . . .	77	.33	.0144	.0188	.0152	.28	.008	.0005	.31	1.7	2,700
September, . .	64	.42	.0131	.0208	.0195	.21	.014	.0002	.48	1.4	12,300
October, . . .	53	.62	.0082	.0246	.0238	.21	.015	.0000	.60	1.2	5,300
November, . .	41	.50	.0051	.0169	.0165	.19	.012	.0000	.50	1.2	5,300
December, . .	34	.49	.0078	.0250	.0226	.20	.018	.0000	.54	1.8	10,700
Average, . .	52	.44	.0094	.0198	.0174	.20	.014	.0001	.42	1.3	7,100

Monthly Averages of Analyses of Effluent from the City Filter.

[Parts per 100,000.]

1896.	Temperature. Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Soluble.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Bacteria per Cubic Centimeter.
January,	37	.40	.0093	.0105	.0102	.21	.036	.0000	.36	2.18	192
February,	35	.40	.0074	.0111	.0099	.22	.035	.0000	.33	2.10	296
March,	36	.44	.0097	.0079	[illegible]	.19	[illegible]	.0000	.27	1.60	297
April,	47	.39	.0080	.0077	.0071	.14	.033	[illegible]	.22	1.60	47
May,	67	.34	.0074	.0078	.0073	.22	.035	[illegible]	.24	1.70	56
June,	61	.37	.0087	.0101	.0101	.22	.034	.0000	.25	1.90	23
July,	73	.21	.0075	.0068	.0065	.29	.045	.0001	.16	1.90	[illegible]
August,	75	[illegible]	.0066	.0067	.0061	.28	.039	.0000	.15	2.00	[illegible]
September,	66	.29	.0073	.0105	.0098	.23	.043	.0001	.26	1.90	87
October,	55	.42	.0106	.0122	.0118	.26	.053	[illegible]	.25	2.30	30
November,	49	.40	.0097	.0111	.0105	.20	.031	[illegible]	[illegible]	1.93	87
December,	35	.44	.0086	.0125	.0116	.19	.036	.0000	.37	1.66	156
Average,	53	.36	.0084	.0096	.0090	.22	[illegible]	.0000	.27	1.90	118

Monthly Averages of Analyses of Water from the Outlet of the Distributing Reservoir.

[Parts per 100,000.]

1896.	Temperature. Deg. F	Color.	Ammonia Free.	Ammonia Albuminoid. Total.	Ammonia Albuminoid. Soluble.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Bacteria per Cubic Centimeter.
January,	35	.43	.0074	.0123	.0118	.21	.040	[illegible]	.37	2.06	[illegible]
February,	39	.30	.0073	.0108	.0102	.22	.041	.0000	.30	2.30	221
March,	26	.40	0075	.0077	.0076	20	.039	.0000	.26	2.10	319
April,	41	.35	.0058	.0087	.0061	.16	.036	.0000	.22	1.60	70
May,	61	.29	.0032	.0085	.0078	.21	.041	.0000	.21	1.80	75
June,	63	.29	.0030	.0163	.0097	.22	.043	[illegible]	.22	2.10	28
July,	74	.21	.0029	.0091	.0081	.28	[illegible]	.0001	.17	2.10	180
August,	75	.17	.0037	.0082	.0073	.29	.065	.0002	.16	2.10	161
September,	65	.24	.0031	.0099	.0093	.24	.044	.0000	.20	1.90	77
October,	55	.31	.0060	.0116	.0112	.26	.052	.0000	.24	2.00	[illegible]
November,	46	.50	.0057	.0112	.0109	.22	.037	.0000	[illegible]	2 05	50
December,	35	.45	.0074	.0119	.0114	.19	[illegible]	[illegible]	.34	1.60	48
Average,	52	.34	.0062	.0100	.0095	.23	.041	.0000	.26	1.97	115

Monthly Averages of Analyses from a Tap at the Lawrence City Hall.

[Parts per 100,000.]

1896.	Temperature. Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Bacteria per Cubic Centimeter.
January,	42	.42	.0058	.0115	.20	.041	.0000	.37	2.00	98
February,	38	.37	.0060	.0097	.22	.043	.0001	.30	1.98	154
March,	38	.39	.0066	.0084	.20	.038	.0000	.24	1.85	95
April,	44	.35	.0046	.0085	.16	.036	.0000	.18	1.58	59
May,	62	.29	.0024	.0076	.20	.042	.0000	.21	1.80	42
June,	62	.27	.0015	.0099	.22	.048	.0000	.21	2.00	32
July,	70	.19	.0013	.0072	.28	.011	.0001	.17	2.00	144
August,	74	.16	.0015	.0078	.30	.036	.0001	.14	2.00	104
September,	67	.19	.0024	.0090	.24	.044	.0001	.18	1.90	78
October,	57	.30	.0030	.0108	.28	.047	.0000	.23	2.00	40
November,	48	.48	.0048	.0113	.22	.035	.0000	.37	2.03	37
December,	39	.44	.0059	.0113	.19	.046	.0000	.35	1.75	124
Average,	53	.32	.0038	.0094	.23	.039	.0000	.25	1.89	84

Monthly Averages of Analyses of Water from a Tap at the Lawrence Experiment Station.

[Parts per 100,000.]

1896.	Temperature. Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Bacteria per Cubic Centimeter.
January,	40	.41	.0173	.0108	.20	.044	.0000	.36	2.05	74
February,	39	.36	.0038	.0100	.22	.046	.0000	.30	1.95	144
March,	40	.38	.0042	.0080	.20	.041	.0000	.24	1.85	157
April,	43	.34	.0029	.0079	.16	.037	.0000	.17	1.50	43
May,	54	.27	.0015	.0079	.20	.044	.0000	.20	1.70	30
June,	58	.25	.0018	.0099	.22	.047	.0000	.20	2.00	31
July,	67	.17	.0014	.0073	.28	.044	.0000	.16	1.90	86
August,	70	.15	.0011	.0062	.30	.040	.0000	.18	2.00	66
September,	67	.16	.0021	.0086	.24	.045	.0001	.17	2.00	47
October,	58	.28	.0026	.0100	.34	.050	.0000	.22	2.00	35
November,	53	.47	.0022	.0116	.22	.040	.0000	.36	2.00	30
December,	39	.48	.0029	.0111	.24	.046	.0000	.32	1.70	38
Average,	50	.31	.0036	.0091	.24	.044	.0000	.24	1.88	65

SEWAGE DISPOSAL

OF

CITIES AND TOWNS IN MASSACHUSETTS

BY

INTERMITTENT FILTRATION.

Sewage Disposal of Cities and Towns in Massachusetts by Intermittent Filtration.

During the year 1896 works for the disposal of sewage were constructed at Natick, Leicester and the Westborough Insane Hospital. The results of examinations of sewage and effluent collected from the various works and examined during the year 1896 are given in the tables which follow, together with statistics as to the works. At the end of 1896 there were 11 cities and towns in the State in which the purification of the sewage is effected by filtration through beds of gravel or sand, and the sewage of several large institutions is disposed of by this method.

Sewage Disposal at Brockton.

The sewage disposal works of the city of Brockton were first put in operation in November, 1894. The total number of connections delivering sewage to the sewers during the last quarter of 1896 was 309, of which 154 were from dwelling-houses and 155 from factories, business blocks, hotels and public buildings.

The following table, taken from the report of the city engineer of Brockton for 1896, gives the average amount of sewage disposed of and the average temperature of the sewage as it reached the beds: —

Month.	Average Daily Flow at Field (Gallons).	Temperature Sewage at Field (Degrees F.).
January,	474,000	43.5
February,	568,400	42.6
March,	648,500	42.4
April,	475,100	45.0
May,	321,900	52.1
June,	381,700	56.8
July,	322,800	59.9
August,	365,900	62.2
September,	527,100	61.0
October,	600,100	57.4
November,	616,000	54.1
December,	559,000	49.9

The results of examinations of the sewage and effluent from these works made in March, 1897, are given below.

Chemical Examination of Sewage from Brockton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.		Residue on Evaporation.					
				Total Residue.			Loss on Ignition.		
		Turbidity.	Sediment.	Total.	Dis-solved.	Sus-pended.	Total.	Dis-solved.	Sus-pended.
	1896.								
16206	March 9	Thick.	Heavy, dark.	65.00	20.80	44.20	40.00	6.60	33.40
16207	March 9	Decided, milky.	Slight.	22.20	20.20	2.00	7.00	6.80	0.20

Chemical Examination of Sewage from Brockton — Concluded.

[Parts per 100,000.]

Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.		Iron.		Hardness.
	Albuminoid.										
Free.	Total.	Dis-solved.	Sus-pended.		Nitrates.	Nitrites.	Unfiltered.	Filtered.	Unfiltered.	Filtered.	
1.3120	.8960	.1720	.7240	8.40	.0080	.0010	7.66	1.20	.3100	.0460	6.9
1.1640	.1920	.1120	.0800	8.20	.0160	.0600	2.66	1.42	.0600	.0500	6.0

Odor, offensive. —— The samples were collected as the sewage flowed out upon the filter beds. The first sample was collected when the sewage contained a large amount of sludge, occasioned by the agitation of the sewage in the receiving reservoir.

Chemical Examination of Effluent from an Underdrain at the Brockton Sewage Disposal Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1896.												
16208	March 9	None.	None.	.00	13.60	.1920	.0070	2.92	.3150	.0012	.09	2.7	.0000

Odor, musty. —— The sample was collected from the underdrain near Pearl Street, and contains a large amount of ground water.

Sewage Disposal at Framingham.

At the end of 1896 about 850 dwelling-houses and 50 business blocks, stores, factories, etc., were connected with the sewers. The Women's Prison, having a population of about 300, located within the limits of the town of Sherborn, is also connected with the works.

Analyses of samples of the sewage and effluent collected during the year are given in the tables which follow: —

Chemical Examination of Sewage from Framingham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.		Residue on Evaporation.					
				Total Residue.			Loss on Ignition.		
		Turbidity.	Sediment.	Total.	Dis-solved.	Sus-pended.	Total.	Dis-solved.	Sus-pended.
	1896.								
15887	Jan. 15	Decided, milky.	Distinct, black.	175.40	31.60	143.80	145.20	12.20	133.00
15978	Jan. 29	Thick.	Cons., earthy.	314.20	26.60	287.60	275.60	11.00	264.60
16056	Feb. 12	Thick.	Cons.	310.80	31.20	279.60	271.80	15.40	256.40
16150	Feb. 26	Thick.	Cons., sandy.	247.40	23.40	224.00	215.60	7.80	207.80
16236	Mar. 11	Decided.	Cons.	155.00	20.60	134.40	125.00	5.40	119.60
16326	Mar. 26	Decided.	Heavy, black.	460.20	28.20	432.00	413.80	11.20	402.60
16416	April 15	Thick.	Very heavy.	203.60	34.40	169.20	164.00	10.80	153.20
16592	May 13	Thick.	Very heavy.	682.20	57.40	624.80	558.20	29.40	528.80
16761	June 10	Thick.	Heavy, dark.	68.20	31.80	36.40	40.40	10.40	30.00
16989	July 15	Thick.	Heavy, dark.	62.20	41.80	20.40	29.60	11.80	17.80
17195	Aug. 13	Thick.	Heavy, dark.	189.00	44.60	144.40	135.60	13.20	122.40
17415	Sept. 9	Decided, heavy.	Heavy.	52.20	41.20	11.00	21.40	12.60	8.80
17646	Oct. 15	Decided.	Heavy, black.	59.00	32.40	26.60	33.00	10.40	22.60
17837	Nov. 11	Decided.	Heavy.	450.40	56.20	394.20	375.80	17.80	358.00
18040	Dec. 9	Thick.	Very heavy.	298.20	29.40	268.80	261.60	9.40	252.20
18186	Dec. 23	Thick, milky.	Heavy, dark.	415.40	32.40	383.00	371.00	8.60	362.40
Av.	....	....	....	246.26	37.63	208.63	199.82	13.08	186.74

Chemical Examination of Sewage from Framingham — Concluded.

[Parts per 100,000.]

Number.	Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.		Iron.		Hardness.
		Albuminoid.										
	Free.	Total.	Dis-solved.	Sus-pended.		Nitrates.	Nitrites.	Unfiltered.	Filtered.	Unfiltered.	Filtered.	
15887	1.6000	2.5200	.2320	2.2880	4.78	.0000	.0000	12.59	2.81	0.3100	0.1200	6.6
15978	2.0000	1.7300	.2500	1.4800	4.22	.0030	.0000	9.75	2.26	0.3400	0.0600	4.7
16056	1.6800	7.6100	.5700	7.0400	3.60	.0050	.0022	25.52	3.60	0.6000	0.1600	16.4
16150	1.4400	4.1400	.2800	3.8600	3.30	.0050	.0000	12.05	2.54	0.5100	0.0900	9.8
16236	1.1600	3.7900	.1500	3.6400	3.54	.0000	.0000	16.81	1.79	0.3100	0.0500	7.0
16326	1.0000	8.1800	.2540	7.9260	3.90	.0050	.0000	18.37	2.50	1.4000	0.3800	18.3
16416	2.8800	1.9120	.3680	1.5440	5.50	.0000	.0000	14.09	3.35	0.2600	0.0720	6.7
16592	4.8000	5.3500	.7400	4.6100	5.46	.0050	.0010	39.86	2.30	4.2000	1.0400	11.3
16761	2.7520	0.8940	.3820	0.5120	6.40	.0000	.0010	5.93	2.12	0.1500	0.0500	6.9
16989	2.1600	0.5040	.2420	0.2620	11.20	.0000	.0000	4.18	2.98	0.1240	0.0720	6.7
17195	3.1360	1.3880	.2640	1.1240	12.40	.0000	.0000	10.67	2.92	0.2500	0.0840	6.0
17415	2.0800	0.3800	.1920	0.1880	8.78	.0050	.0000	3.26	1.80	0.1600	0.0900	6.2
17646	2.8800	0.6680	.2300	0.4380	6.98	.0000	.0000	8.18	2.96	0.1360	0.0560	8.3
17837	6.4000	5.6400	.4600	5.1800	10.50	.0070	.0000	31.36	4.54	1.0200	0.2760	5.4
18040	3.4000	2.4300	.3100	2.1200	6.25	.0030	.0000	23.13	4.72	0.3300	0.1040	4.3
18186	2.2000	1.5800	.4500	1.1300	9.40	.0000	.0000	28.88	4.64	0.6300	0.0860	4.6
Av.	2.5607	2.7272	.3438	2.3834	7.23	.0023	.0003	15.92	2.95	0.7096	0.1883	7.8

Odor, offensive. — The sewage was collected as it flowed out upon the filter beds.

Chemical Examination of Effluent from the East Underdrain of the Framingham Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.
		Turbidity.	Sediment.	Color.	Cold.	Hot.	
	1896.						
15889	Jan. 15	None.	None.	.00	Distinctly earthy.	Decidedly musty.	20.90
15980	Jan. 29	Slight.	Slight.	.02	Faintly musty and unpleasant.	Distinctly musty and disagreeable.	19.80
16058	Feb. 12	V slight.	Slight.	.02	Distinctly musty and disagreeable.	Decidedly musty and disagreeable.	18.30
16151	Feb. 26	Distinct.	Sl't, earthy.	.10	Distinctly unpleasant.	Distinctly disagreeable.	18.80
16238	Mar. 11	None.	V. slight.	.08	Distinctly musty.	Decidedly musty.	18.00
16328	Mar. 26	V. slight.	None.	.03	Distinctly disagreeable.	Distinctly musty.	17.10
16418	April 15	V. slight.	V. slight.	.01	Decidedly musty.	Decidedly musty and disagreeable.	23.50
16594	May 13	None.	None.	.00	None.	Faintly musty.	22.50
16763	June 10	None.	Slight.	.00	Distinctly musty.	Decidedly musty.	33.00
16991	July 15	None.	None.	.00	None.	None.	34.70
17197	Aug. 13	None.	V. slight.	.01	Faintly musty.	Faintly musty.	33.80
17417	Sept. 9	None.	V. slight.	.01	None.	None.	29.60
17648	Oct. 15	None.	Slight.	.02	None.	Faintly mouldy.	27.70
17839	Nov. 11	None.	V. slight.	.03	None.	None.	27.30
18042	Dec. 9	V. slight.	V. slight.	.01	None.	Faintly musty.	30.60
18188	Dec. 23	None.	None.	.00	Oily.	None.	27.70
Av..	....	....	....	.02	....	....	26.47

Chemical Examination of Effluent from the East Underdrain of the Framingham Filter Beds — Concluded.

[Parts per 100,000.]

Number.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
	Free.	Albuminoid.		Nitrates.	Nitrites.			
15889	.0800	.0060	4.02	0.5250	.0020	.10	4.9	.0020
15980	.4080	.0270	4.64	0.3000	.0075	.27	4.9	.0050
16058	.4880	.0220	3.80	0.1800	.0100	.23	4.6	.0130
16151	.5920	.0160	4.02	0.2800	.0050	.21	4.6	.0120
16238	.4000	.0010	3.67	0.2800	.0030	.20	4.3	.0150
16328	.3280	.0070	3.58	0.3700	.0020	.40	7.3	.0030
16418	.5920	.0090	3.72	0.6800	.0030	.16	5.3	.0030
16594	.1200	.0120	3.98	0.8000	.0010	.12	7.0	.0010
16763	.3440	.0130	5.18	1.3000	.0030	.15	10.0	.0030
16991	.0136	.0040	6.30	1.0000	.0012	.11	7.2	.0010
17197	.1160	.0270	6.60	1.1250	.0060	.15	8.4	.0010
17417	.0144	.0064	6.99	0.5600	.0008	.04	5.9	.0000
17648	.0320	.0060	6.02	1.0000	.0010	.17	6.9	.0100
17839	.0360	.0058	5.92	0.6000	.0020	.10	5.9	.0100
18042	.0576	.0066	6.02	1.3750	.0030	.19	6.9	.0030
18188	.0720	.0088	6.56	1.0000	.0020	.13	6.2	.0040
Av..	.2067	.0109	5.24	0.7683	.0029	.15	6.5	.0048

The samples were collected from the underdrain at its outlet.

Chemical Examination of Effluent from the West Underdrain at the Framingham Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Odor. Cold.	Odor. Hot.	Residue on Evaporation.
	1896.						
15868	Jan. 15	None.	V. slight	.02	Faintly earthy.	Decidedly musty.	21.70
15979	Jan. 29	None.	None.	.00	None.	Faintly musty.	20.90
16057	Feb. 12	None.	None.	.00	None.	Faintly musty.	21.40
16162	Feb. 26	None.	None.	.02	None.	Faintly musty.	22.00
16237	Mar. 11	V. slight.	V. slight	.04	Distinctly musty.	Decidedly musty.	18.60
16327	Mar. 26	V. slight.	None.	.02	Distinctly mouldy.	Distinctly musty.	18.70
16417	April 15	V. slight.	V. slight.	.02	Distinctly musty.	Decidedly musty.	20.70
16593	May 13	None	V. slight	.03	None	Distinctly musty.	29.00
16762	June 10	Distinct.	Cons., dark.	.01	Distinctly mouldy.	Distinctly mouldy.	20.80
16990	July 15	V. slight.	V. slight.	.02	Faintly musty.	V. faintly musty.	37.00
17196	Aug. 13	Sl't, milky and floc.	Slight.	.12	Distinctly musty.	Decidedly musty.	34.50
17416	Sept 9	None	V. slight.	.15	None.	Faintly musty	34.00
17647	Oct 15	Slight.	Slight.	.20	Faintly unpleasant.	Distinctly unpleasant.	21.60
17838	Nov. 11	Distinct.	Cons	.08	Dis. disagreeable.	Decidedly disagreeable.	28.00
18041	Dec 9	Distinct.	Slight.	.33	None.	Distinctly musty.	17.70
18187	Dec. 23	None.	V. slight.	.01	V. faintly musty.	Faintly musty.	28.30
Av.				.07			25.89

Chemical Examination of Effluent from the West Underdrain at the Framingham Filter Beds — Concluded.

[Parts per 100,000.]

Number	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
15868	.0560	.0060	3.40	0.8300	.0014	.06	5.1	.0130
15979	.0392	.0056	3.41	1.0000	.0012	.12	4.9	.0100
16057	.0376	.0068	3.52	0.8600	.0011	.08	5.6	.0160
16162	.0400	.0070	3.40	1.0500	.0007	.16	5.0	.0220
16237	.2120	.0180	3.56	0.4000	.0022	.21	4.3	.0100
16327	.0440	.0080	3.42	0.8600	.0010	.09	6.0	.0160
16417	.0328	.0056	3.59	0.8000	.0018	.07	6.7	.0140
16593	.0424	.0124	5.00	1.0500	.0076	.14	6.7	.0250
16762	.0520	.0156	2.18	0.3000	.0065	.15	8.0	.0390
16990	.0204	.0054	6.00	1.1000	.0010	.13	8.1	.0080
17196	.0720	.0190	7.20	0.5750	.0066	.19	7.4	.0450
17416	.0280	.0060	7.11	0.5250	.0018	.14	6.0	.0500
17647	.0800	.0120	4.90	0.5500	.0020	.32	5.9	.0500
17838	.1760	.0106	5.58	0.6250	.0040	.13	7.7	.0640
18041	.0592	.0220	3.50	0.5500	.0006	.50	4.3	.0580
18187	.0848	.0084	6.40	1.1000	.[illegible]	.14	7.6	.0150
Av.	.0656	[illegible]	4.74	0.7412	.0030	.16	6.4	.0312

The samples were collected from the underdrain at its outlet.

Chemical Examination of Water from a Spring near Bannister Brook which receives Effluent from the Framingham Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.
		Turbidity.	Sediment.	Color.	Cold.	Hot.	
	1896.						
15890	Jan. 15	None.	None.	.00	None.	None.	18.80
15981	Jan. 29	None.	None.	.00	None.	None.	17.50
16059	Feb. 12	None.	None.	.00	None.	None.	18.70
16149	Feb. 26	None.	None.	.00	None.	None.	19.00
16239	Mar. 11	None.	None.	.02	None.	Faintly earthy.	19.20
16329	Mar. 26	None.	None.	.00	None.	None.	17.60
16419	Apr. 15	None.	None.	.00	None.	None.	16.40
16595	May 13	None.	None.	.00	None.	None.	17.80
16764	June 10	None.	V. slight.	.00	None.	None.	19.10
16992	July 15	None.	None.	.00	None.	None.	20.20
17198	Aug. 13	None.	None.	.00	None.	None.	19.70
17418	Sept. 9	None.	V. slight.	.00	None.	None.	22.30
17649	Oct. 15	None.	V. slight.	.00	None.	None.	20.10
17841	Nov. 11	None.	None.	.02	None.	Faint.	18.00
18044	Dec. 9	None.	Slight.	.00	None.	None.	19.10
18189	Dec. 23	None.	None.	.00	None.	None.	19.30
Av..	....	....	....	.00	....	....	19.02

Chemical Examination of Water from a Spring near Bannister Brook which receives Effluent from the Framingham Filter Beds — Concluded.

[Parts per 100,000.]

Number.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
	Free.	Albuminoid.		Nitrates.	Nitrites.			
15890	.0000	.0034	3.19	.7000	.0000	.03	4.4	.0040
15981	.0008	.0024	3.30	.7000	.0000	.06	4.6	.0050
16059	.0006	.0022	3.60	.8000	.0000	.06	5.1	.0150
16149	.0000	.0016	3.42	.6000	.0000	.00	4.7	.0020
16239	.0006	.0016	3.44	.5400	.0000	.01	4.6	.0000
16329	.0000	.0026	3.42	.7300	.0000	.04	6.0	.0020
16419	.0008	.0020	3.00	.5000	.0000	.01	4.2	.0000
16595	.0000	.0026	3.41	.6000	.0000	.01	4.3	.0010
16764	.0004	.0028	3.40	.6800	.0000	.06	5.5	.0020
16992	.0002	.0022	3.50	.7500	.0001	.05	4.9	.0010
17198	.0000	.0042	3.40	.6250	.0003	.03	4.9	.0040
17418	.0002	.0076	3.56	.5000	.0000	.01	5.2	.0000
17649	.0004	.0046	3.61	.7200	.0000	.05	4.9	.0450
17841	.0000	.0014	3.50	.6000	.0000	.02	4.7	.0060
18044	.0000	.0020	3.56	.6250	.0000	.10	5.3	.0000
18189	.0006	.0018	3.58	.7500	.0000	.30	5.7	.0030
Av..	.0003	.0030	3.43	.6415	.0000	.04	4.9	.0030

Chemical Examination of Water from Bannister Brook below the Framingham Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
16994	July 14	Distinct.	Cons., brown.	.20	13.70	3.80	.0038	.0224	.0096	.0128	2.28	.5500	.0013	.32	3.4
17200	Aug. 13	Slight.	Slight, dark.	.12	22.60	6.75	.0084	.0090	.0070	.0020	4.24	.5000	.0030	.19	5.0
17420	Sept. 9	Slight.	Cons., earthy.	.18	27.35	5.20	.0096	.0116	.0078	.0038	4.50	.3600	.0018	.26	4.7
Av.	....	....	....	.17	21.22	5.25	.0073	.0142	.0081	.0062	3.67	.4700	.0020	.26	4.4

Odor of the first and last samples, vegetable; of the second, none, becoming faintly mouldy on heating. —— The samples were collected from the brook, at the first road crossing below the sewage field.

Sewage Disposal at Gardner.

The area used for the disposal of sewage at Gardner was enlarged in 1896 by the construction of several new filter beds, bringing the total area up to about 2.75 acres. The quantity of sewage delivered to the filter beds is not definitely known. At the end of 1896 the sewers were used by 432 families, 38 business blocks, hotels and public buildings, 5 school-houses and 11 factories, and it is estimated that the total number of people connected with the sewers is about 5,500. The total length of the sewers is a little over 9 miles.

Chemical Examination of Sewage from Gardner.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.		Residue on Evaporation.					
				Total Residue.			Loss on Ignition.		
		Turbidity.	Sediment.	Total.	Dis-solved.	Sus-pended.	Total.	Dis-solved.	Sus-pended.
	1896.								
15892	Jan. 15	Thick, milky.	Heavy, white.	37.60	21.60	16.00	23.40	10.20	13.20
15976	Jan. 29	Decided, milky.	Cons., floc.	18.20	14.00	4.20	9.40	6.20	3.20
16054	Feb. 12	Decided, milky.	Cons.	27.00	15.40	11.60	14.80	5.00	9.80
16153	Feb. 26	Thick.	Cons.	29.60	22.60	7.00	17.80	13.00	4.80
16241	Mar. 11	Decided.	Cons.	29.80	20.40	9.40	16.60	9.40	7.20
16323	Mar. 25	Decided.	Cons.	46.00	32.20	13.80	31.40	18.40	13.00
16421	Apr. 15	Thick.	Heavy.	31.60	17.00	14.60	17.60	5.20	12.40
16601	May 13	Thick, milky.	Heavy.	41.80	23.00	18.80	24.00	9.00	15.00
16768	June 10	Decided, milky.	Heavy.	57.40	19.00	38.40	24.60	6.60	18.00
17001	July 15	Thick.	Cons.	34.60	22.80	11.80	19.00	10.00	9.00
17191	Aug. 12	Thick.	Heavy, white.	29.00	20.00	9.00	17.00	9.40	7.60
17411	Sept. 9	Decided, heavy.	Heavy.	59.60	29.20	30.40	39.20	12.80	26.40
17644	Oct. 14	Decided.	Heavy, brown.	27.00	19.20	7.80	12.20	5.80	6.40
17850	Nov. 11	Decided.	Heavy.	30.00	20.60	9.40	17.00	8.80	8.20
18032	Dec. 9	Thick.	Heavy.	25.80	18.20	7.60	11.80	8.00	3.80
18184	Dec. 23	Decided, milky.	Heavy.	53.80	28.60	25.20	38.60	16.00	22.60
Av.	....	....	....	37.07	21.44	15.63	21.04	9.22	11.82

Chemical Examination of Sewage from Gardner — Concluded.

[Parts per 100,000.]

Number.	Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.		Iron.		Hardness.
		Albuminoid.										
	Free.	Total.	Dis-solved.	Sus-pended.		Nitrates.	Nitrites.	Unfiltered.	Filtered.	Unfiltered.	Filtered.	
15892	2.0800	0.5240	0.3460	.1780	2.79	.0000	.0160	4.60	2.71	.0580	.0500	3.4
15976	2.5600	0.3180	0.1620	.1560	2.12	.0180	.0550	2.07	1.56	.0360	.0200	3.8
16054	3.5200	0.6420	0.3100	.3320	2.88	.0050	.0010	3.04	2.04	.0540	.0200	4.4
16153	2.2000	0.5000	0.4100	.0900	2.80	.0550	.0095	4.77	3.20	.0440	.0140	4.3
16241	1.9840	0.4040	0.2220	.1820	2.86	.0950	.0170	3.29	1.72	.0400	.0200	3.6
16323	2.0800	1.3880	1.0380	.3500	3.36	.0350	.0180	3.47	2.30	.0560	.0360	5.0
16421	3.8400	1.1020	0.5160	.5860	2.98	.0020	.0000	3.97	2.23	.0700	.0280	4.3
16601	3.9200	0.7900	0.4300	.3600	3.40	.0030	.0000	3.76	2.30	.0760	.0560	3.4
16768	3.3280	0.6520	0.2880	.3640	2.78	.0050	.0000	5.52	2.52	.9000	.1800	2.9
17001	5.1200	0.5680	0.2300	.3380	3.40	.0000	.0000	4.50	3.02	.0780	.0540	3.3
17191	1.6800	0.4600	0.1800	.2800	2.40	.0000	.0000	3.51	1.87	.1080	.0660	4.0
17411	1.9200	0.5520	0.2340	.3180	3.82	.0050	.0000	3.07	1.95	.1700	.0500	4.0
17644	1.9200	0.3620	0.1620	.2000	2.85	.0010	.0000	3.08	2.13	.1160	.0520	3.5
17850	1.4560	0.5980	0.3940	.2040	2.94	.0800	.0000	4.02	3.10	.1000	.0320	3.7
18032	1.4400	0.3720	0.1740	.1980	2.30	.0800	.0050	3.16	1.38	.3600	.0460	4.0
18184	1.9200	0.6240	0.4320	.1920	4.14	.0700	.0100	7.28	5.28	.0800	.0360	4.7
Av.	2.6730	0.6225	0.3318	.2907	3.02	.0229	.0055	3.94	2.43	.1652	.0495	3.8

Odor, offensive. —— The sewage was collected as it flowed upon the beds.

Chemical Examination of Effluent from the Main Underdrain of the Gardner Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Odor. Cold.	Odor. Hot.	Residue on Evaporation.
	1896.						
15893	Jan. 15	Decided, milky.	Slight.	.30	Offensive.	Offensive.	17.40
15977	Jan. 29	Distinct, milky.	Slight.	.30	Distinctly musty and disagreeable.	Decidedly musty and disagreeable.	17.20
16055	Feb. 12	Distinct, milky.	Slight.	.40	Offensive.	Decidedly musty and disagreeable.	13.70
16154	Feb. 26	Decided.	Slight.	.50	Distinctly disagreeable.	Offensive.	15.60
16242	Mar. 11	Decided.	Slight.	.50	Offensive.	Offensive.	12.70
16324	Mar. 25	Decided.	Slight.	.40	Offensive.	Offensive.	13.30
16422	Apr. 15	Decided.	Cons.	.30	Offensive.	Offensive.	15.90
16602	May 13	Distinct.	Cons., rusty.	.70	Offensive.	Offensive.	20.50
16769	June 10	Distinct.	Slight.	.40	Decidedly disagreeable.	Decidedly disagreeable.	18.30
17003	July 15	Decided, milky.	Sl't, rusty.	.30	Decidedly disagreeable.	Decidedly musty and disagreeable.	20.90
17192	Aug. 12	Decided, milky.	Cons., rusty.	.55	Offensive.	Offensive.	18.70
17412	Sept. 9	Distinct.	Cons.	.27	Offensive.	Offensive.	21.10
17645	Oct. 14	Sl't, milky.	Slight.	.08	Faintly musty and unpleasant.	Decidedly musty and unpleasant.	15.30
17851	Nov. 11	Distinct.	Cons.	.17	Distinctly disagreeable.	Decidedly disagreeable.	15.40
18033	Dec. 9	Distinct.	Slight.	.18	Decidedly musty.	Decidedly musty.	14.10
18185	Dec. 23	Sl't, milky.	Slight.	.10	Distinctly musty.	Decidedly musty.	17.90
Av..	....	....	....	.34	....	....	17.50

Chemical Examination of Effluent from the Main Underdrain of the Gardner Filter Beds — Concluded.

[Parts per 100,000.]

Number.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
15893	0.8320	.0620	3.02	.3350	.1000	.75	3.5	.0480
15977	1.3440	.1160	3.07	.4000	.1000	.16	4.4	.0400
16055	1.1600	.1120	2.63	.1800	.0100	.89	2.9	.0980
16154	1.6000	.1200	2.94	.1900	.0090	.96	2.5	.1450
16242	1.6000	.0740	2.78	.1200	.0130	.86	2.3	.1400
16324	0.5200	.0640	3.01	.0900	.0090	.71	4.3	.1250
16422	1.1840	.0640	2.62	.3000	.0250	.71	4.0	.1650
16602	1.0400	.0900	3.24	.5300	.0190	.67	4.4	.4800
16769	0.6720	.0760	2.52	.5100	.0040	.49	5.3	.2050
17003	0.3380	.0300	3.00	.9000	.0040	.51	4.8	.1200
17192	0.4960	.0900	2.60	.4500	.0100	.73	3.2	.3800
17412	0.3600	.0560	2.74	.5500	.0040	.47	5.0	.4250
17645	0.2160	.0160	2.44	.5500	.0050	.28	4.3	.0500
17851	0.3840	.0340	2.80	.5250	.0200	.10	3.6	.1100
18033	0.4800	.3440	2.59	.4000	.0160	.38	3.2	.0980
18185	0.9280	.0360	4.23	.5250	.0080	.48	4.7	.0580
Av..	0.7435	.0767	2.84	.4529	.0186	.54	4.0	.1926

The samples were collected from the main underdrain at the point where it discharges into the brook.

Chemical Examination of Water from Pond Brook above the Gardner Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	[illegible]														
17004	July 15	Distinct, milky.	Slight, rusty.	.33	24.55	5.75	.0078	.0204	.0192	.0012	6.33	.0600	[illegible]	.42	11.7
17193	Aug. 12	Distinct, milky.	Slight.	.50	14.10	3.10	.0056	.0194	.0182	.0012	2.84	.0300	.0012	.37	5.3
17413	Sept. 9	Slight.	Slight.	.36	17.85	4.60	.0066	.0182	.0142	.0040	3.22	.0480	.0088	.45	5.6
Av.	....	....	....	.40	18.83	4.55	.0066	.0193	.0172	.0021	4.13	.0427	.0038	.41	7.5

Odor, musty and disagreeable.—The samples were collected from the brook, above the point where it is crossed by the main sewer leading to the filter beds.

Chemical Examination of Water from Pond Brook below the Gardner Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1896.														
17003	July 15	Distinct, milky.	Slight, rusty.	.25	21.85	6.70	.0254	.0224	.0210	.0014	5.10	.2000	.0128	.40	7.5
17194	Aug. 12	Distinct, milky.	Slight.	.40	14.70	4.16	.0224	.0246	.0216	.0030	2.80	.1750	.0160	.40	4.7
17414	Sept. 9	Slight.	Slight.	.35	17.70	5.40	.0520	.0200	.0150	.0050	3.04	.2000	.0065	.40	5.6
Av.	....	....	....	.33	18.08	5.42	.0333	.0223	.0192	.0031	3.66	1917	.0118	.40	5.9

Odor, decidedly musty and disagreeable. —— The samples were collected from the brook below the filter beds and below the point where effluent from the filter beds enters the stream.

Sewage Disposal at Leicester.

Works for disposing of the sewage of the central village of the town of Leicester were constructed in 1896 but were only partially completed at the end of the year. They will be described in a subsequent report.

Sewage Disposal at Marlborough.

Additions have been made during 1896 to the works for purifying the sewage of Marlborough, and the total area of filter beds and sludge beds in use at the end of the year, including the beds constructed during the year, was 14.6 acres.

Chemical Examination of Sewage from Marlborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.		Residue on Evaporation.					
				Total Residue.			Loss on Ignition.		
		Turbidity.	Sediment.	Total.	Dis-solved.	Sus-pended.	Total.	Dis-solved.	Sus-pended.
	1896.								
15896	Jan. 15	Thick, milky.	Heavy, grayish.	43.60	34.40	9.20	22.60	13.80	8.80
15982	Jan. 29	Distinct.	Cons.	24.60	23.40	1.20	11.40	11.00	0.40
16066	Feb. 12	Decided, white.	Cons., whitish.	31.20	23.20	8.00	14.10	6.20	7.90
16158	Feb. 26	Decided, milky and floc.	Cons.	34.00	24.40	9.60	15.60	6.20	9.40
16247	Mar. 11	Decided.	Cons., whitish.	26.20	20.40	5.80	12.20	9.40	2.80
16332	Mar. 25	Decided.	Cons.	28.60	22.80	5.80	12.60	7.40	5.20
16431	April 15	Decided, milky and floc.	Cons., gray.	33.60	23.60	10.00	14.00	6.60	7.40
16589	May 12	Distinct, floc.	Cons.	23.60	16.80	6.80	9.40	3.60	5.80
16775	June 11	Thick.	Very heavy.	109.60	42.40	67.20	67.40	15.60	51.80
16995	July 14	Thick.	Heavy, light colored.	58.20	35.40	22.80	32.20	14.00	18.20
17201	Aug. 14	Decided.	Cons.	20.60	17.20	3.40	5.20	3.80	1.40
17423	Sept. 9	Thick.	Heavy, dark.	60.80	43.20	17.60	31.00	16.40	14.60
17652	Oct. 15	Decided.	Heavy, dark.	38.80	26.60	12.20	15.40	7.00	8.40
17854	Nov. 11	Decided.	Heavy.	41.20	32.40	8.80	17.20	10.80	6.40
18056	Dec. 10	Thick.	Heavy.	32.20	24.60	7.60	11.60	7.40	4.20
18190	Dec. 23	Thick, milky.	Heavy, light colored.	48.60	35.20	13.40	24.80	13.60	11.20
Av..	....	....	....	43.41	28.48	14.93	21.19	9.61	11.58

Chemical Examination of Sewage from Marlborough — Concluded.

[Parts per 100,000.]

Number.	Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.		Iron.		Hardness.
		Albuminoid.										
	Free.	Total.	Dis-solved.	Sus-pended.		Nitrates.	Nitrites.	Unfiltered.	Filtered.	Unfiltered.	Filtered.	
15896	3.9680	.7120	.3960	.3160	5.62	.0000	.0000	4.60	3.30	.2100	.1360	6.9
15982	0.2480	.0520	.0360	.0160	2.88	.3750	.0280	2.65	0.78	.0500	.0360	6.9
16066	1.3200	.2740	.1160	.1580	3.80	.0000	.0027	2.43	0.58	.0600	.0360	7.6
16158	1.6000	.4100	.1700	.2400	4.33	.0000	.0000	3.08	1.89	.0700	.0360	6.6
16247	1.9200	.3240	.1120	.2120	3.66	.0430	.1850	2.53	1.73	.1040	.0200	6.0
16332	1.2000	.3900	.1380	.2520	4.17	.0050	.0000	2.43	1.68	.0700	.0400	6.9
16431	1.6000	.3080	.1380	.1700	4.38	.0050	.0010	2.73	0.92	.0800	.0440	5.7
16589	0.4800	.1480	.0560	.0920	3.00	.0600	.0900	1.72	0.97	.0720	.0660	6.1
16775	5.7600	.7320	.3480	.3840	7.60	.0030	.0000	7.05	4.03	.2060	.0220	8.2
16995	2.7200	.7320	.3180	.4140	7.20	.0000	.0000	5.70	3.60	.1900	.1100	5.9
17201	0.4240	.1500	.0580	.0920	3.20	.1000	.0170	1.41	0.90	.0600	.0380	7.1
17423	2.8800	.6240	.2880	.3360	7.18	.0000	.0000	7.57	3.22	.1900	.0900	6.6
17652	1.5040	.3540	.1160	.2380	4.72	.1100	.0800	2.61	1.42	.1440	.0440	8.0
17854	2.0800	.4720	.2960	.1760	5.80	.0050	.0000	3.92	2.50	.1060	.0560	7.4
18056	2.8000	.4660	.1600	.3060	4.60	.0800	.0200	5.50	1.99	.1100	.0200	7.4
18190	2.6400	.6060	.3820	.2240	5.96	.0030	.0200	8.00	6.40	.1640	.0800	7.3
Av..	2.1080	.4281	.1978	.2303	5.05	.0447	.0263	4.03	2.23	.1231	.0560	6.9

Odor, offensive. —— The samples were collected from the separating tanks, and represent the sewage after a portion of the suspended matter has been separated from it.

Chemical Examination of Effluent from the Underdrains of the Marlborough Filter Beds.

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Odor. Cold.	Odor. Hot.
		1896.					
1	15897	Jan. 15	Distinct, milky.	Slight.	.20	Faintly musty.	Decidedly musty and disagreeable.
2	15963	Jan. 29	Distinct, milky.	Slight.	.25	Distinctly musty.	Decidedly musty.
3	15964	Jan. 29	Slight.	Slight.	.06	Distinctly mouldy.	None.
4	16067	Feb. 12	Distinct, milky.	Very slight.	.10	Faintly musty.	Decidedly musty.
5	16068	Feb. 12	Very slight.	Very slight.	.06	Faintly vegetable.	Distinctly musty.
6	16159	Feb. 26	Slight, floc.	Slight.	.04	Distinctly mouldy.	Distinctly musty.
7	16160	Feb. 26	Slight, milky.	Slight.	.05	Distinctly musty.	Faintly musty.
8	16248	Mar. 11	Distinct, milky.	Slight.	.30	Decidedly musty and disagreeable.	Decidedly musty and very disagreeable.
9	16249	Mar. 11	Distinct, milky.	Slight, rusty.	.30	Decidedly musty and disagreeable.	Decidedly musty and disagreeable.
10	16333	Mar. 25	Distinct.	Cons.	.05	Decidedly disagreeable.	Decidedly disagreeable.
11	16334	Mar. 25	Distinct.	Slight.	.25	Decidedly disagreeable.	Decidedly disagreeable.
12	16432	April 15	Slight, milky and floc.	Slight, yellow.	.15	Faintly musty.	Decidedly musty.
13	16433	April 15	Slight, milky.	Slight.	.18	Distinctly musty.	Decidedly musty and disagreeable.
14	16590	May 13	Slight, milky.	Slight.	.20	Decidedly disagreeable.	Decidedly disagreeable.
15	16591	May 13	Slight, milky.	Slight.	.13	Decidedly disagreeable.	Decidedly disagreeable.
16	16776	June 11	Decided, milky.	Heavy, rusty.	.10	Decidedly disagreeable.	Decidedly disagreeable.
17	16777	June 11	Distinct, milky.	Slight.	.12	Decidedly disagreeable.	Decidedly disagreeable.
18	16996	July 14	Distinct, milky.	Slight, rusty.	.58	Distinctly disagreeable.	Distinctly disagreeable.
19	16997	July 14	Distinct, milky.	Slight, rusty.	.60	Decidedly disagreeable.	Decidedly disagreeable.
20	17202	Aug 14	Decided.	Cons.	.60	Offensive.	Offensive.
21	17203	Aug. 14	Decided, rusty.	Heavy, rusty.	.12	Decidedly disagreeable.	Decidedly disagreeable.
22	17424	Sept. 9	Distinct, floc.	Cons., rusty.	.08	Decidedly disagreeable.	Decidedly musty and disagreeable.
23	17425	Sept. 9	Distinct, floc.	Cons., rusty.	.08	Decidedly disagreeable.	Decidedly musty and disagreeable.
24	17653	Oct. 15	Distinct, floc.	Heavy, rusty.	.07	Distinctly disagreeable.	Decidedly musty and disagreeable.
25	17654	Oct. 15	Slight, milky.	None.	.12	Distinctly musty and unpleasant.	Distinctly musty and unpleasant.
26	17865	Nov. 11	Distinct.	Cons.	.57	Decidedly musty and disagreeable.	Decidedly disagreeable.
27	17866	Nov. 11	Distinct.	Cons.	.42	Distinctly musty and disagreeable.	Distinctly disagreeable.
28	18057	Dec. 10	Decided.	Slight.	60	None.	Distinctly musty.
29	18058	Dec. 10	Slight.	Slight.	.03	Distinctly mouldy.	Decidedly musty and disagreeable.
30	18191	Dec. 23	Distinct, milky.	Very slight.	.07	Faintly musty.	Decidedly musty.
31	18192	Dec. 23	Very slight.	Very slight.	.04	Distinctly mouldy.	Distinctly musty and disagreeable.
32	Av.	....	....	....	.21	....	....

Chemical Examination of Effluent from the Underdrains of the Marlborough Filter Beds — Concluded.

[Parts per 100,000.]

Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	
	Free.	Albuminoid.		Nitrates.	Nitrites.				
22.10	0.4880	.0210	3.98	0.4700	.0030	0.22	7.6	.0550	1
23.20	0.8160	.0820	4.84	0.3700	.0100	0.58	6.0	.0600	2
23.50	0.3600	.0200	4.05	0.7000	.0030	0.23	7.1	.0070	3
22.60	0.5120	.0230	3.40	0.7400	.0004	0.30	7.3	.0300	4
21.40	0.5000	.0230	3.42	0.6500	.0005	0.23	5.7	.0070	5
22.40	0.4800	.0260	3.74	0.4200	.0080	0.25	6.0	.0090	6
24.50	0.5600	.0140	4.12	0.8200	.0020	0.18	6.0	.0320	7
21.90	0.4880	.0200	3.60	0.6000	.0040	0.31	5.4	.1260	8
21.40	0.5600	.0140	3.64	0.7000	.0010	0.25	5.7	.1180	9
19.70	0.4880	.0260	3.60	0.4800	.0050	0.26	7.3	.1400	10
18.20	0.5360	.0200	3.30	0.3700	.0080	0.23	5.3	.0350	11
26.10	0.4200	.0130	3.44	1.0500	.0100	0.27	7.7	.1100	12
26.80	0.4880	.0280	4.01	1.1500	.0110	0.29	8.4	.0520	13
30.00	0.4160	.0[illegible]	5.56	0.7000	.0020	0.33	7.4	.0600	14
27.80	0.3600	.0400	5.42	0.9800	.0050	0.37	9.9	.0480	15
32.70	1.0080	.0420	6.40	0.9500	.0070	0.35	9.7	.2420	16
32.20	0.9600	.0600	6.50	0.9000	.0260	0.48	9.0	.0250	17
32.40	0.6260	.0540	6.80	0.9000	.0070	0.33	8.6	.1130	18
35.70	0.7240	.0400	7.30	1.0000	.0180	0.52	8.2	.2800	19
28.10	0.9600	.1660	7.70	0.1500	.0012	1.25	4.7	.5250	20
28.00	1.1360	.0700	7.06	0.2500	.0175	0.92	6.0	.6850	21
36.30	0.2240	.0860	7.22	0.5500	.0160	0.15	7.6	.2250	22
34.10	0.7360	.0460	7.21	0.4750	.0090	0.52	6.9	.4350	23
30.30	0.9280	.0220	6.64	0.8700	.0070	0.38	7.3	.4850	24
31.80	0.6080	.0180	6.84	1.0000	.0020	0.25	7.7	.0500	25
26.90	0.4320	.0400	5.58	0.5500	.0250	0.44	8.9	.2600	26
27.30	0.4448	.0244	6.00	0.5250	.0250	0.34	8.3	.2180	27
28.40	0.7200	.0200	5.41	0.6000	.0080	0.33	7.4	.3200	28
22.00	1.1600	.0260	5.50	0.3750	.0090	0.28	5.6	.0040	29
32.00	0.2280	.0312	5.55	0.9500	.0110	0.39	8.6	.0140	30
22.70	0.4800	.0268	4.98	0.2900	.0100	0.33	6.4	.0120	31
27.96	0.6236	.0416	5.54	0.6885	.0096	0.40	7.4	.1787	32

Chemical Examination of Water from the Brook into which the Effluent from the Marlborough Sewage Filter Beds is discharged.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.	
		Turbidity.	Sediment.	Color.	Cold.	Hot.	Total.	Loss on Ignition.
	1896.							
16998	July 14	Distinct.	Cons., dark brown.	.20	Distinctly musty.	Distinctly musty.	26.40	6.70
17204	Aug. 14	Slight.	Cons., dark.	.20	Distinctly musty.	Decidedly musty.	23.45	4.55
17426	Sept. 9	Slight.	Slight.	.11	Distinctly musty.	Distinctly musty.	27.75	7.50
Av.				.17			25.87	6.25

Chemical Examination of Water from the Brook into which the Effluent from the Marlborough Sewage Filter Beds is discharged — Concluded.

[Parts per 100,000.]

Number.	Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
	Free.	Albuminoid.				Nitrates.	Nitrites.		
		Total.	Dissolved.	Suspended.					
16998	.4960	.0420	.0260	.0160	5.60	.6000	.0190	.36	6.6
17204	.5200	.0460	.0260	.0200	5.82	.4750	.0225	.40	5.6
17426	.3840	.0300	.0300	.0000	5.24	.5250	.0175	.22	5.9
Av.	.4667	.0393	.0273	.0120	5.55	.5333	.0197	.33	6.0

The samples were collected from the brook at the road crossing below the filter beds and below where the effluent from the filter beds enters the stream.

Sewage Disposal at Medfield.

Chemical Examination of Sewage from Medfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.		Residue on Evaporation.					
		Turbidity.	Sediment.	Total Residue.			Loss on Ignition.		
				Total.	Dis-solved.	Sus-pended.	Total.	Dis-solved.	Sus-pended.
	1896.								
15894	Jan. 15	Opaque, black.	Heavy, black.	78.20	62.40	15.80	44.40	32.20	12.20
16234	Mar. 11	Decided, black.	Cons., black.	195.60	177.40	18.20	84.80	70.00	14.80
16603	May 13	Thick, dark.	Heavy, dark.	46.80	35.60	11.20	26.00	16.60	9.40
17006	July 15	Dark.	Cons., black.	43.40	35.60	7.80	15.20	9.00	6.20
17453	Sept. 12	Thick.	Heavy, dark.	42.20	32.00	10.20	22.00	13.20	8.80
17842	Nov. 11	Decided.	Heavy.	74.80	65.00	9.80	48.80	40.60	8.20
Av..	....	.. ..	....	80.17	68.00	12.17	40.20	30.27	9.93

Chemical Examination of Sewage from Medfield — Concluded.

[Parts per 100,000.]

Number.	Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.		Iron.		Hardness.
	Free.	Albuminoid.				Nitrates.	Nitrites.	Unfiltered.	Filtered.	Unfiltered.	Filtered.	
		Total.	Dis-solved.	Sus-pended.								
15894	1.9200	1.8300	1.4400	.3900	3.90	.0000	.0000	13.32	8.79	.1760	.1400	5.1
16234	2.1200	2.8000	2.1300	.6700	17.20	-	-	60.84	39.00	.1100	.0800	13.9
16603	2.6400	1.2800	1.0500	.2300	3.02	.0050	.0000	6.01	3.67	.1300	.0600	5.3
17006	1.6000	0.4160	0.2260	.1900	11.00	.0000	.0000	4.15	2.86	.0780	.0600	4.2
17453	2.0000	0.2820	0.1440	.1380	3.60	.0040	.0000	5.38	3.70	.1240	.0640	5.6
17842	1.4400	1.0920	0.9680	.1240	4.04	.0070	.0000	10.69	8.49	.1100	.0900	3.9
Av..	1.9533	1.2833	0.9930	.2903	7.13	.0032	.0000	16.73	11.08	.1213	.0823	6.3

Odor, offensive.——The samples were collected as the sewage flowed upon the filter beds.

Chemical Examination of Water from a Spring below the Filtration Area of the Medfield Sewerage System.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.
		Turbidity.	Sediment.	Color.	Cold.	Hot.	
	1896.						
15895	Jan. 15	V. slight.	V. slight.	.05	None.	Faintly earthy.	5.50
16235	Mar. 11	V. slight.	V. slight.	.04	None.	Faintly earthy.	5.20
16604	May 13	V. slight.	V. slight.	.20	Faintly musty.	Distinctly musty.	4.40
17007	July 15	Distinct.	Cons., rusty.	.90	Distinctly mouldy.	Distinctly vegetable.	10.30
17454	Sept. 12	Distinct.	Cons., rusty.	.20	Distinctly musty.	Faintly musty.	16.50
17843	Nov. 11	Distinct.	Cons.	.18	Faintly disagreeable.	Distinctly disagreeable.	10.80
Av..	....	....	....	.26	....	....	8.78

Chemical Examination of Water from a Spring below the Filtration Area of the Medfield Sewerage System — Concluded.

[Parts per 100,000.]

Number.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
	Free.	Albuminoid.		Nitrates.	Nitrites.			
15895	.0032	.0060	0.53	.1100	.0005	.11	1.7	.0060
16235	.0008	.0054	0.56	.1700	.0000	.11	2.0	.0020
16604	.0000	.0068	0.45	.0150	.0000	.19	1.7	.0230
17007	.0018	.0286	0.56	.0500	.0001	.88	3.3	.1050
17454	.0088	.0162	1.18	.0580	.0040	.57	5.6	.0780
17843	.0032	.0216	0.81	.1200	.0000	.58	4.7	.0550
Av..	.0030	.0144	0.68	.0872	.0008	.41	3.2	.0450

The samples were collected from the spring which is located north of the filter beds and a little over 260 feet from the edge of the nearest bed. The ground where the filter beds are located slopes in the direction of this spring.

Sewage Disposal at Natick.

Population in 1895, 8,814. A system of sewerage and of sewage disposal was put in operation in the latter part of 1896 for collecting and disposing of the sewage of the town of Natick.

The sewage is collected on the westerly side of the thickly settled portion of the town and conveyed to a pumping station near the south-westerly end of Lake Cochituate, from which it is pumped to a sewage-disposal area located near the Worcester turnpike and on the opposite side from the area used by the town of Framingham. The filtration area contains nearly 100 acres, three-quarters of which can apparently be utilized for filtration purposes. About three acres of filter beds were prepared for use in the beginning with underdrains discharging into Bannister Brook, just above the Framingham filtration area.

A further description of these works, together with analyses of the sewage and effluent, will be given in a subsequent report.

FOOD AND DRUG INSPECTION.

FOOD AND DRUG INSPECTION.

The operations of the Board under the provisions of the food and drug acts for the year ending Sept. 30, 1896, are detailed in the following report.

The following persons comprised the force employed by the Board during the year: —

Dr. CHARLES P. WORCESTER,	*Analyst.*
Prof. CHARLES A. GOESSMANN,	*Analyst.*
Mr. ALBERT E. LEACH,	*Assistant Analyst.*
JOHN H. TERRY,	*Inspector.*
JOHN F. MCCAFFREY,	*Inspector.*
HORACE F. DAVIS,	*Inspector.*
THOMAS O. ALLEN,	*Inspector.*

The whole number of samples of food and drugs (including milk) examined during the year was 8,357, or 1,048 more than the number examined in the year ending Sept. 30, 1895, and 2,453 more than the average annual number examined in the ten years from Sept. 30, 1885, to Sept. 30, 1895.

The whole number examined since the beginning of operations in this department in 1883 was 76,113.

The following summary embraces the work done during the year: —

Number of samples of milk examined,	4,484
Number of samples above standard,	2,904
Number of samples below standard,	1,580
Percentage of adulteration or deficiency,	35.2
Number of samples of other kinds of food (not milk),	3,368
Number of samples above standard,	2,978
Number of samples below standard,	390
Percentage of adulteration,	11.6
Number of samples of drugs examined,	505
Number of samples of good quality,	251
Number of samples adulterated, as defined by the statutes,	254
Percentage of adulteration,	50.3
Total number of samples of food and drugs examined,	8,357
Total number found to be of good quality,	6,133
Total number not conforming to the statutes,	2,224
Percentage of adulteration,	26.6

Attention has already been called, in previous reports, to the fact that the percentages given in the foregoing summary do not represent, in any degree, the actual ratio of adulteration existing in food products and in drugs, for several reasons: chiefly on account of the fact that the experience of the Board enables it, first, to exercise a careful selection of such articles, mainly, as are liable to adulteration; secondly, to obtain such articles in those seasons of the year when their adulteration is most common; and third, to pay special attention to new forms of adulteration which are constantly appearing as fast as the fraud and ingenuity of the professional adulterator present them to the public.

Legislation also has a marked effect upon the figures which represent the conditions of the food supply as found upon analysis. For example, a standard of milk was established by a statute of 1880, requiring that milk should be deemed to be not of good standard quality if not possessing 13 per cent. of total solids; but this law was amended in 1886 by a provision that the standard of quality during two months of the year (May and June) might be 12 per cent. of solids. In 1896 the law was further amended by providing that the number of months in which the standard should be 12 per cent. should be increased to five (April, May, June, July and August). Now, since the number of samples of milk ranging from 12 to 13 per cent. of solids invariably constitutes a large percentage of the whole number collected, the percentage of samples found to be below the legal standard would necessarily be materially diminished by such legislation, while the actual quality, as determined by analysis, might not be changed. This statement is corroborated by that of the principal analyst, to be found on a later page. During the years 1893, 1894 and 1895 the usual collections of milk submitted to examination showed a ratio of about 49 per cent. below the legal standard, while those of the past year, under the amended statute, gave only 35.2 per cent. below the standard.

The following tables present a summary of the work done during the entire period from the beginning of operations under the food and drug acts in 1883 to the close of the year ending Sept. 30, 1896: —

STATISTICAL SUMMARY.

FOOD AND DRUG INSPECTION (1883-96).

SUMMARY.	YEARS.						
	1883.	1884.	1885.	1886.	1887.	1888.	1889.
Number of samples of milk examined,	218	1,123	2,219	2,085	3,081	2,825	3,219
Number of samples above standard,	35	347	1,297	1,323	1,900	1,705	1,971
Number of samples below standard,	183	776	922	762	1,181	1,120	1,248
Percentage of adulteration,	83.9	69.1	41.7	36.5	38.3	39.6	38.7
Number of samples of other kinds of food (not milk),	477	839	1,552	1,353	1,789	2,079	1,635
Number of samples of good quality,	328	432	883	863	1,263	1,680	1,242
Number of samples adulterated, as defined by the statutes,	149	407	669	490	556	399	393
Percentage of adulteration,	31.2	48.5	43.1	36.2	29.4	19.2	24.0
Number of samples of drugs examined,	603	682	1,007	888	550	862	600
Number of samples of good quality,	357	431	571	463	400	634	503
Number of samples adulterated, as defined by the statutes,	246	251	436	425	150	228	97
Percentage of adulteration,	40.8	36.8	43.3	47.8	27.3	26.4	16.2
Total examinations of food and drugs,	1,298	2,644	4,778	4,326	5,420	5,766	5,454
Total examinations of good quality,	720	1,210	2,751	2,649	3,563	4,019	3,716
Total examinations not conforming to the statutes,	578	1,434	2,027	1,677	1,857	1,747	1,738
Percentage of adulteration,	44.5	54.2	42.7	38.7	34.3	30.3	31.9
Expense of collection, examination and prosecution,	$2,931 56	$5,529 60	$8,557 43	$8,025 34	$8,803 62	$8,915 41	$10,356 28
Expense of collection, examination and prosecution, per sample,	2 26	2 09	1 79	1 85	1 62	1 54	1 89

Food and Drug Inspection (1883-96) — *Concluded.*

Summary.	Years.							Totals.
	1890.	[illegible]	1892.	1893.	1894.	1895.	1896.	
Number of samples of milk examined,	3,236	2,726	3,271	3,073	3,551	3,794	4,484	38,905
Number of samples above standard,	1,858	1,629	1,757	1,545	1,794	1,905	2,904	21,970
Number of samples below standard,	1,378	1,097	1,514	1,528	1,757	1,889	1,580	16,935
Percentage of adulteration,	42.6	40.2	46.3	49.7	49.5	49.8	35.2	43.5
Number of samples of other kinds of food examined (not milk),	2,349	2,144	2,441	3,009	2,836	2,971	3,368	28,842
Number of samples of good quality,	1,913	1,577	2,042	2,637	2,566	2,379	2,978	22,783
Number of samples adulterated, as defined by [illegible] statutes,	436	567	399	372	270	592	390	6,059
Percentage of adulteration,	18.6	26.4	16.3	12.3	9.5	19.9	11.6	21.0
Number of samples of drugs examined,	400	424	487	327	487	544	505	8,366
Number of samples of good quality,	325	352	312	228	324	212	251	5,363
Number of samples adulterated, as defined by the statutes,	75	72	175	99	163	332	254	3,003
Percentage of adulteration,	18.7	17.0	35.9	30.3	33.5	61.0	50.3	35.9
Total examinations of food and drugs,	5,985	5,294	6,199	6,409	6,874	7,309	8,357	76,113
Total examinations of good quality,	4,096	3,558	4,111	4,410	4,684	4,496	6,133	50,116
Total examinations not conforming to the statutes,	1,889	1,736	2,088	1,999	2,190	2,813	2,224	25,997
Percentage of adulteration,	31.5	32.8	33.7	31.2	31.9	38.5	26.6	34.2
Expense of collection, examination and prosecution,	$10,013 04	$10,019 41	$11,180 30	$10,454 11	$10,364 64	$11,375 89	$10,921 61	$127,448 24
Expense of collection, examination and prosecution, per sample,	1 67	1 89	1 80	1 63	1 52	1 56	1 23	1 67

From the foregoing tables it appears that 76,113 samples of food and drugs have been collected by the inspectors of the Board and submitted to the analysts for examination during the fourteen years in which the statutes providing for this work have been in operation. The total cost of the work has been $127,448.24. Enough has already been said in previous reports to show that many times this sum have undoubtedly been saved to the consumers throughout the State.

The cost of collection and analysis per sample has also been reduced nearly one-half. This expense in 1883 amounted to $2.26 per sample, but this amount has been reduced to $1.23 in 1896, a sum much less than that of any preceding year. Part of this saving is due to the concentration of the greater part of the work of analysis under one head at the State House laboratory.

By a requirement of the statute the greater part of the appropriation for the work of this department is expended in the inspection of milk and milk products and the enforcement of the laws relating to these valuable articles of food. Hence the greater portion of the samples collected are of this character.

In the last annual report the results of a single street collection of milk taken from milk wagons in one city were published, the average solids of 20 samples being 12.98.

Attention is called to the statement of the analyst relative to the change of standard and its effect upon the ratio of apparent adulteration, and the method of detection of formalin. A further table of analyses of condensed milk is also presented, in addition to those which were published last year. Analyses of eight samples of evaporated cream, of six different brands, are also presented, in which it is shown, as well as in the case of some of the brands of condensed milk, that the cream has been largely removed, thus depriving them of an important ingredient of high value as a nutrient.

The following table presents the results of analysis of the milk of 20 animals, all of which were of one herd of Holstein cows, which had the reputation of being an unusually good herd of cattle: —

Age of Cow.	Time Since Calving.	Breed.	Results of Analysis.						
			Specific Gravity.	Fat.	Sugar.	Albuminoids.	Ash.	Total Solids.	Water.
Years.	Months.								
3 1/6, .	6	Holstein,	1.028	3.40	4.50	3.27	0.55	11.22	88.78
6 1/2, .	7	"	1.029	3.80	4.10	3.63	0.50	12.03	87.97
5, . .	3	"	1.029	3.30	4.30	4.44	0.64	12.68	87.32
6 7/12, .	4	"	1.030	3.20	4.00	3.44	0.51	11.15	88.85
4 1/4, .	4	"	1.028	6.20	3.00	4.87	0.65	14.82	85.18
6 1/2, .	5	"	1.029	2.60	4.30	3.02	0.60	10.52	89.48
5 1/6, .	3	"	1.030	3.30	4.40	3.05	0.68	11.43	88.57
3 1/4, .	6	"	1.031	3.20	4.50	3.40	0.62	11.72	88.28
2 1/2, .	–	"	1.031	4.70	4.30	3.89	0.66	13.55	86.45
2 5/6, .	2	"	1.031	3.40	4.40	3.78	0.67	12.25	87.75
4 1/3, .	4	"	1.031	3.40	4.60	4.16	0.62	12.78	87.22
9 1/3, .	8	"	1.030	2.70	4.00	3.42	0.42	10.54	89.46
6 1/2, .	11	"	1.031	3.80	4.00	4.07	0.50	12.37	87.63
11 1/6, .	2	"	1.031	3.40	4.10	3.69	0.58	11.77	88.23
6 1/4, .	4	"	1.031	3.60	4.00	4.10	0.56	12.26	87.74
11, . .	1 1/2	"	1.029	2.70	3.50	3.46	0.56	10.22	89.78
3 1/3, .	11	"	1.033	3.80	4.40	3.92	0.68	12.80	87.20
6 1/4, .	7	"	1.032	4.20	4.30	4.30	0.62	13.42	86.58
3 5/12, .	4	"	1.030	3.00	4.00	3.73	0.62	11.35	88.65
3 7/12, .	9	"	1.033	3.70	4.00	4.07	0.70	12.47	87.53
Average, ...			1.030	3.57	4.13	3.79	0.60	12.07	87.93

For further analyses of milk of known purity see page 628.

The principal articles of food found to be adulterated during the year were olive oil, lard, honey, molasses, maple syrup and sugar, spices, especially cayenne, vinegar, coffee, cocoa and cream of tartar.

Drugs.

The principal drugs found adulterated or below the standard were ether, alcohol, ammonia water and chlorine water, distilled water (in this article the solids varied from 0 to 73 per 100,000 parts), calx chlorata, extracts of liquorice and nux vomica, powdered opium, compound spirits of ether, spirits of nitrous ether, whiskey, tincture of iodine, syrup, tincture of opium, mercurial ointment, white and red wine.

Notices.

The following lists present the names of the cities and towns to which notices were issued relating to the adulteration of different kinds of food and drugs: —

Cities and Towns to which Notices were sent on Account of Adulterated Milk.

Beverly,	2	Milford,	1
Boston:		Natick,	1
Allston,	2	New Bedford,	1
Charlestown,	2	Newburyport,	1
East Boston,	3	Newton,	6
Roxbury,	1	Quincy,	1
Brockton,	3	Revere,	4
Brookline,	5	Rockland,	1
Cambridge,	13	Somerville,	14
Canton,	2	Springfield,	5
Chelsea,	15	Sterling,	1
Dedham,	2	Stoneham,	1
Everett,	6	Stoughton,	3
Fall River,	6	Waltham,	4
Fitchburg,	3	Watertown,	3
Gloucester,	4	Westford,	1
Hull,	1	Winchester,	2
Lexington,	1	Winthrop,	1
Malden,	10	Woburn,	1
Marblehead,	2	Worcester,	4
Marlborough,	3		
Medford,	10	Total,	155
Melrose,	3		

Cities and Towns to which Notices were sent on Account of Adulterated Articles of Food other than Milk.

Boston:		Lowell,	1
Allston,	2	Malden,	1
Boston,	21	Nantasket,	1
Charlestown,	2	Nantucket,	1
Dorchester,	1	New Bedford,	3
East Boston,	1	Pittsfield,	2
Mattapan,	1	Provincetown,	3
South Boston,	1	Salem,	3
West Roxbury,	1	Somerville,	3
Cambridge,	5	South Framingham,	1
Chelsea,	2	Springfield,	7
Chicopee,	2	Waltham,	1
Cottage City,	1	Watertown,	1
Everett,	1	Webster,	9
Fall River,	3	Westfield,	4
Gardner,	1	Woburn,	1
Gloucester,	2	Worcester,	3
Haverhill,	1		—
Holyoke,	2	Total,	95

Cities and Towns to which Notices were sent on Account of Adulterated Drugs.

Boston:		Lowell,	1
Allston,	2	Nantasket,	1
Boston,	7	New Bedford,	3
Brockton,	2	Northampton,	2
Brookline,	1	Somerville,	2
Cambridge,	1	Stoughton,	1
Chelsea,	1	Taunton,	1
Chicopee,	1	Worcester,	2
Clinton,	2		—
Greenfield,	1	Total,	31

PROSECUTIONS.

In the reports of the last four years a condensed summary was presented, showing the number of prosecutions conducted in each year since the beginning of work under the food and drugs acts. The following table presents the same figures, with the addition of those for the year ending Sept. 30, 1896: —

Number of Complaints entered in Court.

YEAR.	Food (not including Milk).	Drugs.	Milk.	Total.	Convictions.	Fines Imposed.
1883, . . .	–	5	4	9	8	-‡
1884, . . .	2	1	45	48	44	-‡
1885,* . . .	50	1	68	119	103	-‡
1886,† . . .	10	–	10	20	19	-‡
1887, . . .	30	–	34	64	60	-‡
1888, . . .	22	–	43	65	61	$2,042 00
1889, . . .	74	–	66	140	124	3,889 00
1890, . . .	78	–	24	102	96	3,919 00
1891, . . .	96	5	49	150	135	2,668 00
1892, . . .	52	12	72	136	123	3,661 70
1893, . . .	26	3	67	96	92	2,476 00
1894, . . .	14	–	76	90	77	2,625 00
1895, . . .	13	11	68	92	86	2,895 30
1896, . . .	7	–	68	75	74	2,812 20
Totals, . .	474	38	694	1,206	1,102	$26,988 20

* To May 1, 1886. † Four months only. ‡ No record kept.

Ratio of convictions to complaints, 91.4 per cent.

NOTE. — All complaints entered before May 1, 1886, were under the direction of the Board of Health, Lunacy and Charity, and all after that date were under the direction of the State Board of Health.

The following report was presented to the Legislature in January, 1897, in compliance with the provisions of the statutes: —

OFFICE OF THE STATE BOARD OF HEALTH,
STATE HOUSE, BOSTON, Jan. 1, 1897.

To the Honorable Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The following summary is made in compliance with the provisions of chapter 289, section 2, of the Acts of 1884, requiring the State Board of Health to "report annually to the Legislature the number of prosecutions made under chapter 263 of the Acts of 1882, and an itemized account of all money expended in carrying out the provisions thereof."

The whole number of prosecutions made by authority of the Board against offenders, under the provisions of the food and drug acts, for the year ending Sept. 30, 1896, was 75.

The cities and towns in which the articles were sold, and in respect to which complaints were entered in court, the character of the articles found to be adulterated, or fraudulently sold, the dates of the trials, and their results, are presented in the following table: —

MILK AND MILK PRODUCTS.

For Fraudulent Sales of Milk.

PLACE.	DATE.	RESULT.
In Chelsea,	Nov. 29, 1895,	Convicted.
Chelsea,	May 22, 1896,	"
Chelsea,	July 9, 1896,	"
Chelsea,	Sept. 9, 1896,	Discharged.
Somerville,	Dec. 3, 1895,	Convicted.
Somerville,	Dec. 3, 1895,	"
Somerville,	Sept. 18, 1896,	"
Somerville,	Sept. 18, 1896,	"
Salem,	Aug. 11, 1896,	"
Salem,	Aug. 11, 1896,	"
Salem,	Aug. 11, 1896,	"
Fall River,	Nov. 20, 1895,	"
Fall River,	July 15, 1896,	"
Worcester,	June 24, 1896,	"
Cambridge,	May 9, 1896,	"
Cambridge,	May 9, 1896,	"
Springfield,	Dec. 26, 1895,	"
Fitchburg,	Jan. 28, 1896,	"
Woburn,	Dec. 26, 1895,	"
Woburn,	Dec. 26, 1895,	"
Newton,	Nov. 14, 1895,	"
Beverly,	Dec. 9, 1895,	"
Brookline,	April 11, 1896,	"
Boylston,	Oct. 1, 1895,	"
Boylston,	Oct. 1, 1895,	"
Westborough,	Oct. 25, 1895,	"
Westborough,	Oct. 25, 1895,	"
Westborough,	July 13, 1896,	"
Northborough,	Oct. 25, 1895,	"
Northborough,	July 13, 1896,	"
Athol,	Oct. 7, 1895,	"
Royalston,	Oct. 7, 1895,	"
Stoneham,	Oct. 26, 1895,	"
Watertown,	Dec. 10, 1895,	"
Watertown,	April 24, 1896,	"
Agawam,	Dec. 26, 1895,	"
Reading,	March 31, 1896,	"
Reading,	March 31, 1896,	"
Reading,	March 31, 1896,	"
Reading,	April 10, 1896,	"

For Fraudulent Sales of Milk — Concluded.

Place.	Date.	Result.
In Reading,	July 28, 1896,	Convicted.
Reading,	July 28, 1896,	"
Peabody,	April 29, 1896,	"
Westfield,	April 21, 1896,	"
Milford,	April 28, 1896,	"
Arlington,	May 2, 1896,	"
Arlington,	May 2, 1896,	"
Natick,	June —, 1896,	"
Wakefield,	June 13, 1896,	"
Topsfield,	Aug. 11, 1896,	"
Topsfield,	Aug. 11, 1896,	"
Stoughton,	Aug. 28, 1896,	"
Sturbridge,	Aug. 12, 1896,	"
Sudbury,	Aug. 13, 1896,	"
Sudbury,	Aug. 13, 1896,	"
Hardwick,	Aug. 14, 1896,	"
Hardwick,	Aug. 14, 1896,	"
Marblehead,	Sept. 8, 1896,	"
Marblehead,	Sept. 8, 1896,	"
Marblehead,	Sept. 8, 1896,	"
Marblehead,	Sept. 8, 1896,	"
Walpole,	Sept. 17, 1896,	"
Dover,	Sept. 18, 1896,	"
Dover,	Sept. 18, 1896,	"
Brookfield,	Sept. 22, 1896,	"
Brookfield,	Sept. 22, 1896,	"
Dracut,	Feb. 28, 1896,	"
Tewksbury,	March 24, 1896,	"
Total,		68

FOR FRAUDULENT SALE OF OTHER ARTICLES OF FOOD.

Maple Sugar.

In Boston,	April 23, 1896,	Convicted.
Boston,	April 30, 1896,	"
Salem,	May 1, 1896,	"
Roxbury,	May 11, 1896,	"

Maple Syrup.

In Fitchburg,	April 30, 1896,	Convicted.

Molasses.

In North Adams,	Sept. 28, 1896,	Convicted.

Cream of Tartar.

In North Adams,	Sept. 28, 1896,	Convicted.
Total,		7

SUMMARY.

Complaints entered in court under the acts relating to the inspection of milk and milk products,	68
Other articles of food,	7
Total,	75

SUMMARY.

The whole number of complaints entered by the State Board of Health during the year ending Sept. 30, 1896, in the courts of the Commonwealth, against parties for violation of the statutes relating to food and drug inspection, was 75.

In 74, or 98.7 per cent., of these the parties were convicted. One was discharged in the municipal court.

Of the whole number, 68 were for violation of the laws relating to milk adulteration, and of this number 67 resulted in conviction. The greater number of these was for violation of the statute providing that milk offered for sale shall be of good standard quality.

In 10 of the foregoing cases the complaints were for sales of milk containing coloring matter.

The attention of the Legislature is again respectfully called to the provisions of chapter 425 of the Acts of 1894, which debars any private citizen from maintaining an action against a producer for selling adulterated milk.

Attention is also respectfully called to the provisions of section 23 of chapter 397 of the Acts of 1896, by which the people are now deprived of any legal protection against the harmful action of poisonous patent medicines.

All of the 7 parties against whom complaints were entered for fraudulent sales of other kinds of food were convicted.

The articles of food with reference to which these complaints were made were as follows: —

Maple sugar, 4 cases; maple syrup, 1 case; molasses, 1 case; cream of tartar, 1 case.

The following statute, as amended in 1896 (chapter 398), presents the standard of milk in Massachusetts at the date of publishing this report: —

[CHAPTER 398, SECTION 2, ACTS OF 1896.]

In all prosecutions under this chapter, if the milk is shown upon analysis to contain less than thirteen per cent. of milk solids, or to contain less

than nine and three-tenths per cent. of milk solids, exclusive of fat, or to contain less than three and seven-tenths per cent. of fat, it shall be deemed, for the purposes of this act, to be not of good standard quality, except during the months of April, May, June, July and August, when milk containing less than twelve per cent. of milk solids, or less than nine per cent. of milk solids exclusive of fat, or less than three per cent. of fat, shall be deemed to be not of good standard quality.

The following list presents the total solids in each of the samples of milk upon which complaints were founded, so far as records of the same were kept: —

7.09	10.00	10.52	11.04	11.30
7.13	10.20	10.56	11.06	11.30
8.69	10.20	10.57	11.10	11.39
8.75	10.24	10.62	11.11	11.42
9.20	10.24	10.64	11.14	11.44
9.26	10.34	10.66	11.16	11.60
9.32	10.38	10.77	11.18	11.64
9.71	10.40	10.79	11.19	11.76
9.80	10.42	10.86	11.25	11.78
9.81	10.42	10.90	11.26	12.60
9.84	10.43	10.96	11.28	12.62
9.92	10.49			

The total number of samples of food and drugs examined during the year was as follows: —

Milk,	4,484
Other articles of food,	3,368
Drugs,	486
Total,	8,338

Total expenses of collection, examination and prosecution,	$10,921 61
Average expense per sample collected,	1 31

Fines.

The amount of fines paid into the treasuries of counties, cities and towns under the provisions of the general and special laws relative to the inspection of food and drugs was as follows: —

Fines paid for Violation of the Food and Drug Acts, upon Cases entered for the Year ending Sept. 30, 1896.

Under the provisions of the laws relating to milk and milk products,	$2,742 20
Under the provisions of the laws relating to other articles of food,	70 00
Total,	$2,812 20

Expenditures.

Under the Provisions of the Food and Drug Acts during the Year ending Sept. 30, 1896.

	For the Enforcement of the Statutes relating to Food and Drug Inspection.	
	Relative to Milk and Milk Products.	Relative to Other Kinds of Food and Drugs.
Salaries of analysts,	$2,700 00	$1,800 00
Salaries of inspectors,	2,500 00	1,550 00
Travelling expenses and purchase of samples,	1,115 00	736 64
Apparatus and chemicals,	160 78	95 39
Printing,	25 35	17 50
Books,	–	20 00
Index cards and guides,	37 77	20 00
Express charges,	–	3 15
Extra services,	77 33	38 67
Sundry small supplies (bottles, etc.),	16 03	8 00
	$6,632 26	$4,289 35
		6,632 26
Total,	. . . .	$10,921 61

Proprietary Medicines.

During the course of its work in the inspection of food and drugs, a considerable number of specimens of proprietary medicines has been examined by the analysts of the Board, and the results of analysis have been published in the annual reports. These published statements are scattered through different reports covering several years, and some of them are out of print. There is an increasing demand for the information contained in them, and it has been thought advisable to republish the results in a condensed form, in answer to this demand, with such additions as have been made during the past year.

The following list contains a condensed statement of the results of analysis of most of the proprietary articles alluded to above. In very many instances the preparations were examined for the presence of some single ingredient only, where this ingredient was found to be a poisonous substance, injurious to the health of persons using it.

Cosmetics.

The following contain acetate of lead (sugar of lead) or some active lead compound: —

	Per Cent. of Lead Contained.
Ayer's Hair Vigor, contained the equivalent of about	0.30
"Renown" Hair Restorer, contained the equivalent of about	1.86
Mrs. Allen's Hair Restorer, contained the equivalent of about . . .	2.30
American Hair Restorative, contained the equivalent of about. . .	0.61
Barrett's Vegetable Hair Restorative, contained the equivalent of about .	0.22
Chevalier's Life for the Hair, contained	Much.
Hall's Vegetable Sicilian Hair Renewer, contained the equivalent of about	1.75
Wood's Hair Restorative, contained the equivalent of about . . .	1.59
Ring's Vegetable Ambrosia, contained the equivalent of about . .	1.51
Parker's Hair Balsam, contained the equivalent of about	2.32
Wolf's Vegetable Hair Restorer, contained the equivalent of about . .	0.95

Instances of lead poisoning have been known to occur from the free external use of such preparations as the foregoing.

The following contained corrosive sublimate, or some other poisonous salt of mercury, in the proportion of 1 to 15 grains per ounce: —

Harriet Hubbard Ayer's Recamier Cream, Balm and Lotion.
Madame Ruppert's World Renowned Face Bleach.
Madame Yale's Excelsior Complexion Bleach.
Hill's Freckle Lotion.
Soule's Freckle and Moth Eradicator.
Perry's Freckle Lotion.
Oriental Cream.
Mrs. McCorrison's Famous Diamond Face Lotion (14.7 grains to the ounce).
Royal Cream.

In one instance a six-ounce bottle contained 47 grains of corrosive sublimate. Another contained 14 grains of the bichloride per ounce. It is not surprising that instances of serious harm were reported from the use of such articles.

Tonics and Bitters.

The following were examined for the purpose of ascertaining the percentage of alcohol in each. Some of them have been recommended as temperance drinks: —

	Per Cent. of Alcohol (by Volume).*
"Best" Tonic, ...	7.6
Carter's Physical Extract, ...	22.0
Hooker's Wigwam Tonic, ...	20.7
Hoofland's German Tonic, ...	29.3

* In this list the percentages of alcohol are reckoned by volume; in more recent lists, by weight. Percentages by volume may be converted into percentages by weight and *vice versa* by means of the table published in the U. S. Pharmacopœia of 1890, pages 531-537.

	Per Cent. of Alcohol (by Volume).*
Hop Tonic,	7.0
Howe's Arabian Tonic, "not a rum drink,"	13.2
Jackson's Golden Seal Tonic,	19.6
Liebig Company's Coca Beef Tonic,	23.2
Mensman's Peptonized Beef Tonic,	16.5
Parker's Tonic, "purely vegetable," "recommended for inebriates,"	41.6
Schenck's Sea Weed Tonic, "entirely harmless,"	19.5
Atwood's Quinine Tonic Bitters,	29.2
L. T. Atwood's Jaundice Bitters,	22.3
Moses Atwood's Jaundice Bitters,	17.1
Baxter's Mandrake Bitters,	16.5
Boker's Stomach Bitters,	42.6
Brown's Iron Bitters,	19.7
Burdock Blood Bitters,	25.2
Carter's Scotch Bitters,	17.6
Colton's Bitters,	27.1
Copp's White Mountain Bitters, "not an alcoholic beverage,"	6.0
Drake's Plantation Bitters,	33.2
Flint's Quaker Bitters,	21.4
Goodhue's Bitters,	16.1
Greene's Nervura,	17.2
Hartshorn's Bitters,	22.2
Hoofland's German Bitters, "entirely vegetable and free from alcoholic stimulant,"	25.6
Hop Bitters,	12.0
Hostetter's Stomach Bitters,	44.3
Kaufmann's Sulphur Bitters, "contains no alcohol." As a matter of fact, it contains 20.5 per cent. of alcohol and no sulphur,	20.5
Kingsley's Iron Tonic,	14.9
Langley's Bitters,	18.1
Liverpool's Mexican Tonic Bitters,	22.4
Paine's Celery Compound,	21.0
Pierce's Indian Restorative Bitters,	6.1
Puritana,	22.0
Z. Porter's Stomach Bitters,	27.9
Pulmonine,	16.0
Rush's Bitters,	35.0
Richardson's Concentrated Sherry Wine Bitters,	47.5
Secor's Cinchona Bitters,	13.1
Shonyo's German Bitters,	21.5
Job Sweet's Strengthening Bitters,	29.0
Thurston's Old Continental Bitters,	11.4
Walker's Vinegar Bitters, "contains no spirit,"	6.1
Warner's Safe Tonic Bitters,	35.7
Warren's Bilious Bitters,	21.5
Wheeler's Tonic Sherry Wine Bitters,	18.8

* See note on page 615.

	Per Cent. of Alcohol (by Volume).*
Wheat Bitters,	13.6
Faith Whitcomb's Nerve Bitters,	20.3
Dr. Williams's Vegetable Jaundice Bitters,	18.5
Whiskol, "a non-intoxicating stimulant, whiskey without its sting,"	28.2
Colden's Liquid Beef Tonic, "recommended for treatment of alcohol habit,"	26.5
Ayer's Sarsaparilla,	26.2
Thayer's Compound Extract of Sarsaparilla,	21.5
Hood's Sarsaparilla,	18.8
Allen's Sarsaparilla,	13.5
Dana's Sarsaparilla,	13.5
Brown's Sarsaparilla,	13.5
Corbett's Shaker Sarsaparilla,	8.8
Radway's Resolvent,	7.9

The dose recommended upon the labels of the foregoing preparations varied from a teaspoonful to a wineglassful, and the frequency also varied from one to four times a day, "increased as needed."

"*Opium Cures.*"

Each of the so-called cures furnished by the following persons, mostly in Ohio, Indiana and Illinois, were found to contain morphine in variable amounts: —

H. L. Baker.	J. C. Hoffman.
J. C. Beck.	H. H. Kane.
C. C. Beers.	F. E. Marsh.
G. A. Bradford.	L. Meeker.
P. B. Bowzer.	Wm. P. Phelon.
J. S. Carleton.	Salvo Remedy Co.
S. B. Collins.	W. B. Squire.
B. S. Dispensary.	J. L. Stevens.
J. A. Drollinger.	B. M. Woolley.
J. R. A. Dunn.	

Dr. Buckland's Scotch Oats Essence.

The so-called Keeley's Double Chloride of Gold Cure, at first advertised as a remedy for the opium habit, was also examined by the Board in 1884, and found to contain not a trace of gold.

"*Blood Purifiers.*"

An examination of the so-called "sarsaparilla" remedies, or "blood purifiers," was made in 1892, and in nearly every instance the remedy was found to contain iodide of potassium in variable amounts.

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* See note on page 615.

The following general comments upon these preparations were made in the report of that year: —

With but few exceptions they contain a considerable percentage of a very active and powerful remedy, the iodide of potassium. . . . The sale of such an article in unlimited quantities by druggists, grocers and others is censurable. More than this, the method of its sale is dishonest, since the unwary purchaser is led to believe that he is purchasing a harmless vegetable remedy, namely, sarsaparilla.

It may be seriously questioned whether the blood of persons who take iodide of potassium continuously is not decidedly impoverished, instead of being purified, as is claimed by the manufacturers. It is not uncommon to find persons who have used continuously six, eight or ten pint bottles of one of these preparations.

Unlike sarsaparilla, the iodide of potassium is classed among poisons by nearly every writer upon toxicology.

The Board quotes several noted authorities upon this subject. The pale, sallow complexion of the habitual user of the "sarsaparilla iodides" is unfortunately too often met with, wherever these remedies are freely advertised and sold.

The following list presents the percentage of iodide of potassium found in those samples which have been submitted to the analyst for examination: —

"So-called" Sarsaparilla Remedies.

Name.	Per Cent. of Iodide of Potassium.	Name.	Per Cent. of Iodide of Potassium.
Wilson's,	0.32	Coleman & Co.'s,	0.83
Howe's,	0.33	Bass's,	0.84
White's,	0.38	Brown's,	1.00
No name,	0.41	Leavitt's,	1.00
Charles's,	0.41	Moriarty's,	1.11
Mahern's,	0.41	Dana's,	1.17
Ayer's,	0.45	Woodward's,	1.33
Bartlett's,	0.50	Dudley's,	1.50
No name,	0.50	Cherry & Wingate's,	1.55
No name,	0.50	Jaynes's,	1.59
Packard's,	0.58	Nims's,	1.67
Raynsford's,	0.58	Cherry & Wingate's,	1.67
Adams's,	0.75	Mattison's,	2.00
Broad & Co.'s,	0.75	Myrick's,	2.12
Hood's,	0.75	Leavitt's,	2.17
Hutchinson's,	0.75	Church's,	2.25
Dr. White's,	0.75		

The active ingredient was in nearly all instances the iodide of potassium, but in one or more of the samples the analyst states that the iodide "was in the form of iodide of iron, and in others probably the sodium salt."

In 1895 the attention of the Board was called to some cases of lead poisoning which had followed the use of certain carbonated syrups and other drinks of an effervescing nature. An examination was made, which resulted in finding that the stoppers of the bottles used for holding these drinks were often made in part of lead, the amount varying in 50 different samples from as low as 1 per cent. to a little over 50 per cent. of lead; and the contents of the bottles also contained variable amounts of lead, the maximum being in the proportion of 0.27 grain per gallon. This quantity would probably vary with the length of time during which the contents were exposed to the lead stoppers.

The following preparations were found to contain cocaine: —

Dr. Birney's Catarrhal Powder was found on analysis to contain hydrochlorate of cocaine, and according to the label each bottle contains 2½ per cent. of this drug, with other ingredients.

Instant Cold Relief, made by the Instant Cold Relief Company of Taunton, contains cocaine with sugar of milk, menthol and common salt.

The danger in using remedies containing cocaine consists in the liability to the formation of a cocaine habit. Instances have been cited in which persons purchasing this remedy have used a half-dozen bottles per day, with the result of producing permanent injury to health. According to the U. S. Dispensatory, the habitual use of cocaine "readily grows upon the individual, and the inveterate user can be recognized by his uncertain step, general apathy, sunken eyes, trembling lips, fetid breath, etc. Incurable insomnia is apt to be developed, emaciation becomes extreme, dropsy ap pears and even death results. Poisoning and even death have resulted both from its internal administration and its local use."

Kaskine, a much vaunted remedy, sold at one dollar an ounce, was found to consist of nothing but granulated sugar.

Modene, an empirical preparation for removing hair, was found to consist of calx sulphurata (sulphurated lime).

Ozonos, a proprietary disinfectant, was found to be a solution of permanganate of potash.

Information in regard to different brands of adulterated spices and other articles of food may be found in the twenty-first annual report of the Board (1889).

Names of brands of French peas colored with sulphate of copper (blue vitriol) were published in the weekly bulletin of May 9, 1891. That portion of the bulletin which contains the monthly food and drug report contains considerable additional information upon special subjects, which is published as occasion requires.

REPORTS OF THE ANALYSTS.

REPORTS OF THE ANALYSTS.

Dr. S. W. Abbott, *Secretary of State Board of Health.*

Dear Sir: — I have the honor to present my report of the analysis of food and drugs for the year ending Sept. 30, 1896.

Milk.

From the beginning of the collection and examination of milk in 1883 under the food and drug acts to the present time there has been for the most part an annual increase in the number of samples reported. The past year shows a considerably larger number than ever before. For a number of years preceding the present the ratio of the samples of milk which were below the standard analyzed in this laboratory has varied but little from 50 per cent. The record of the present year, however, shows what may appear as a surprising improvement of quality, the samples below the standard amounting to only 35.2 per cent. of the total number analyzed.

But this improved ratio is due to the fact that the legal standard of total solids has been changed. For the months of July and August of the past year the legal standard of total solids was dropped from 13 to 12 per cent., so that a majority of the samples received during those months which under the old standard would have been reported adulterated are here reported of standard quality. Although the law now in force fixes the legal standard at 12 per cent. from April 1 to August 31, this law did not go into effect in time to include April, 1896, which is here reported under the 13 per cent. standard.

The tables show what might naturally be expected, that the percentage of adulteration of the samples collected from towns is considerably lower than in the case of milk from cities, while the milk from the "suspected producer" class is much the poorest of all.

Milk from Cities.

Cities.	Total Samples Collected.	Above Standard.	Below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Colored Samples.
Boston,	185	122	63	34.1	10.95	-	-
Brockton,	48	38	10	20.8	10.45	-	-
Cambridge,	407	226	181	44.4	9.02	-	6
Chelsea,	222	106	116	52.2	8.60	4	1
Everett,	156	79	77	49.3	10.90	-	-
Fall River,	100	78	22	22.0	10.30	-	-
Fitchburg,	84	47	37	44.0	9.80	6	-
Gloucester,	98	71	27	27.5	9.53	-	4
Haverhill,	28	17	11	39.3	10.83	-	-
Lawrence,	24	17	7	29.2	11.34	2	-
Malden,	120	52	68	56.6	10.24	2	4
Marlborough,	17	11	6	35.3	11.32	-	-
Medford,	168	102	66	39.2	10.37	-	-
Newburyport,	38	33	5	13.2	11.56	-	-
Newton,	171	136	35	20.5	11.35	2	2
North Adams,	18	18	0	0.0	13.13	-	-
Quincy,	45	25	20	44.4	11.60	-	-
Salem,	54	33	21	38.8	10.60	-	-
Somerville,	509	318	191	37.5	9.81	-	3
Taunton,	48	40	8	16.6	12.87	4	-
Waltham,	64	26	38	59.4	11.34	-	7
Woburn,	95	67	28	29.5	11.16	-	4
Worcester,	80	63	17	21.2	10.40	1	-
Totals,	2,779	1,725	1,054	37.9	8.60	21	31

Milk from Towns

Towns.	Total Samples Collected.	Above Standard.	Below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Colored Samples.
Arlington,	12	5	7	58.3	11.16	-	2
Beverly,	26	14	12	46.1	9.40	-	-
Brookline,	147	124	23	15.6	9.54	-	1
Canton,	27	23	4	14.8	10.32	-	-
Clinton,	33	25	8	24.2	12.40	4	-
Dedham,	79	55	24	30.4	10.67	-	-
Framingham,	5	5	0	0.0	13.10	-	-
Greenfield,	4	4	0	0.0	12.80	-	-
Holliston,	6	3	3	50.0	12.10	-	-
Hull,	12	11	1	8.3	10.76	-	-
Hyde Park,	103	78	25	24.2	10.18	1	-
Lexington,	10	8	2	20.0	11.56	-	-
Marblehead,	43	26	17	39.5	10.20	-	1
Melrose,	21	4	17	84.3	11.68	-	-
Milford,	36	28	8	22.2	11.08	2	-
Milton,	6	2	4	66.6	12.40	-	-
Montague,	19	15	4	21.0	12.40	1	-
Nantucket,	17	17	0	0.0	12.30	-	-
Natick,	30	27	3	10.0	9.92	-	1
New Bedford,	24	15	9	37.5	11.53	-	-
Plymouth,	24	22	2	8.3	12.00	-	-
Provincetown,	16	16	0	0.0	12.70	1	-
Randolph,	11	10	1	9.1	12.85	-	-
Reading,	29	10	19	65.6	9.26	-	7
Revere,	70	52	18	25.7	9.73	-	-
Rockland,	12	8	4	33.3	11.88	-	-
Salisbury,	18	17	1	5.5	11.68	-	-
Stoneham,	102	86	16	15.7	9.68	-	-
Stoughton,	69	54	15	21.7	7.70	-	-
Wakefield,	24	10	14	58.3	9.32	-	1
Wareham,	12	10	2	16.6	9.80	-	-
Watertown,	45	27	18	39.4	10.00	2	-
Webster,	23	15	8	34.8	10.60	3	-
Wellesley,	4	2	2	50.0	12.60	1	-
Westborough,	17	17	0	0.0	12.00	1	-
Winchester,	60	35	25	41.6	11.04	-	-
Winthrop,	46	41	5	10.8	11.15	-	-
Totals,	1,242	921	321	25.8	7.70	16	13

Milk from Suspected Producers.

Locality.	Total Samples Collected.	Above Standard.	Below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.
Avon,	4	2	2	50.0	10.86
Bedford,	13	5	8	61.5	12.24
Beverly,	5	0	5	100.0	10.19
Brookfield,	12	1	11	91.7	10.42
Charlton,	19	8	11	57.9	10.24
Danvers,	8	5	3	37.5	12.72
Dover,	8	4	4	50.0	8.69
Hardwick,	20	10	10	50.0	10.96
Lexington,	12	9	3	25.0	12.36
Mendon,	3	3	0	0.0	12.56
Northborough,	3	0	3	100.0	8.75
Southborough,	10	3	7	70.0	12.70
Sterling,	3	0	3	100.0	11.36
Stoughton,	6	2	4	66.6	10.42
Sudbury,	12	2	10	83.3	10.77
Topsfield,	16	12	4	25.0	10.34
Upton,	9	2	7	77.7	11.18
Waltham,	4	4	0	0.0	14.08
Walpole,	5	1	4	80.0	7.13
Wayland,	15	10	5	33.3	11.23
Westborough,	5	3	2	40.0	10.43
Westford,	11	5	6	54.5	10.98
Weston,	15	11	4	26.6	12.16
Totals,	218	102	116	53.2	7.13

Summary of Milk Statistics.

	Total Samples Collected.	Above Standard.	Below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Colored Samples.
Cities,	2,779	1,725	1,054	37.9	8.60	21	31
Towns,	1,242	921	321	25.8	7.70	16	13
Suspected producers,	218	102	116	53.2	7.13	-	-
Miscellaneous,	14	6	8	57.1	5.05	-	1
Totals,	4,253	2,754	1,499	35.2	5.05	37	45

More artificially colored milks were found than usual. Forty-five samples proved to be thus sophisticated. They were collected in 14 towns and cities. Of these samples, 39 were colored with annatto and 6 with the aniline orange described in our report for 1895. Many of these colored milks were found to be above the legal standard in total solids. In one instance, in which a conviction was secured in court, the milk contained over 17 per cent. of solids. In this case the aniline orange was used, and the defendant admitted his guilt, urging as an excuse that his customers demanded a more highly colored article than natural milk.

Of the artificial colors, annatto seems to give a pale milk the most natural creamy appearance, and hence it is most extensively used. It is unfortunate for the milkman that when artificial coloring of any kind is used the yellow tint resulting is not confined chiefly to the cream, as is the case with the natural color of milk. It thus happens that when pure milk has stood for a sufficient time to allow the cream to separate, it is found on pouring off the top that the milk underlying the cream has the familiar bluish tint of "skimmed milk." But when an artificially colored milk is treated similarly, the yellow color is found to tinge the milk below the fat layer. In the regular course of analysis this appearance often directs the attention of the analyst to the artificial color, which is afterwards determined by the special tests.

No samples of milk were found to contain an added preservative. The use of formalin as a milk preservative, which is reported from some of the western States, has not been adopted here to any great extent.

A convenient means of detecting its presence in small quantities in milk is by the aid of fuchsine, decolorized by sulphurous acid.* Ten or twelve cubic centimeters of the suspected milk are treated with about 1 cubic centimeter of the decolorized fuchsine solution. After standing a short time, hydrochloric acid is added and the mixture shaken. The presence of formalin is indicated by a violet color, varying in depth according to the amount present. In the absence of formalin the milk shows only a yellowish color after shaking with the acid.

The accompanying table shows the results of the analysis of a series of milks of known purity from a herd of thirty-six cows,

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* Method of G. Denigès, "Jour. Pharm. et Chemie," ser. 6, 4 (1896, page 193).

chiefly grade Holsteins. This milk was taken during February, when the standard is 13 per cent. of solids. It will be seen that the average of the whole herd is materially below the standard.

Analysis of Milks of Known Purity.

Number of Cow.	Age in Years.	Months from Calving.	The Daily Milk per Day (in Pounds).	Daily Rations (in Pounds): Chicago Gluten Meal.*	Daily Rations (in Pounds): Oats, Corn and Wheat.†	Hay per Day (in Pounds).‡	Ensilage per Day (in Pounds).§	Per Cent. Total Solids in Milk.	Per Cent. Fat in Milk.	Per Cent. Solids not Fat in Milk.	Breed of Cow.
1	6	5	26	2	4	10	30	12.14	3.65	8.[illegible]	Grade Holstein.
2	5	1	33	1	4	10	30	14.16	6.10	8.06	Grade Holstein
3	3	5	20	2	4	10	30	11.56	[illegible]	8.26	Thoroughbred Holstein.
4	5	2	22	2	4	10	30	12.70	4.60	8.10	Grade Holstein
5	4	4	25	2	4	10	30	11.36	3.70	7.66	Thoroughbred Holstein.
[illegible]	6	11	8	2	4	10	30	14.99	5.95	9.04	Grade Holstein.
8	6	7	23	2	4	10	30	11.66	3.60	8[illegible]	Grade Holstein.
9	5	5	18	2	4	10	30	13.86	4.70	9.16	Grade Holstein.
10	5	1	25	1	4	10	30	12.48	4.25	8.23	Grade Holstein.
11	7	5	17	2	4	10	30	12.07	3.65	8.42	Grade Holstein.
13	7	4	26	2	4	10	30	11.38	3.55	7.83	Grade Holstein.
15	4	1	30	2	4	10	30	12.98	4.10	8.88	Grade Holstein.
17	6		10	2	4	10	30	12.22	3.60	8.62	Grade Holstein.
18	4	3	21	2	4	10	30	11.14	3.10	8.08	Grade Holstein.
19	8	5	14	2	4	10	30	11.20	3.75	7.45	Thoroughbred Holstein.
20	5	4	22	2	4	10	30	12.30	3.55	8.95	Grade Holstein.
21	7	1	27	2	5	10	30	12.19	3.70	8.49	Thoroughbred Holstein.
22	4	4	10	2	4	10	30	12.02	4.00	8.02	Grade Holstein.
23	6	1	27	2	5	10	30	11.32	3.35	7.97	Grade Holstein
24	8	4	15	2	4	10	30	12.34	3.60	8.74	Grade Holstein and Durham.
25	5	1	25	2	5	10	30	11.29	3.25	8.04	Grade Holstein.
26	5	2	12	2	4	10	30	13.87	5.00	8.87	Grade Guernsey.
27	5	1	15	2	5	10	30	11.18	3.15	8.03	Grade Holstein
28	4	6	22	2	4	10	30	11.98	3.40	8.45	Grade Guernsey.
29	5	1	25	2	4	10	30	11.45	3.40	8.05	Grade Holstein.
31	8	4	30	2	4	10	30	12.40	4.05	8.35	Grade Holstein.
33	7	7	13	2	4	10	30	12.86	4.30	8.56	Grade Holstein.
34	5	2	30	2	4	10	30	12.24	4.20	8.04	Grade Holstein.
35	6	1	30	2	5	10	30	14.00	5.40	8[illegible]	Grade Holstein.
36	5	1	29	2	4	10	30	12.10	4.15	7.95	Grade Holstein.
37	5	2	22	2	5	10	30	10.96	3.20	7.76	Grade Holstein.
39	5	2	19	2	4	10	30	11.75	3.70	8.05	Grade Holstein.
40	6	1	24	2	4	10	30	12.47	4.25	8.42	Grade Holstein.
41	6	1	30	2	5	10	30	11.28	3.20	8.08	Grade Holstein.
42	6	1	14	2	4	10	30	12.30	3.19	9.11	Grade Holstein.
46	5	2	24	2	5	10	30	11.60	3.60	8.00	Grade Holstein.
Average for herd,								12.22	3.93	8.29	

* Sometimes replaced by "old-process" linseed meal.

† A mixture of 4 parts oats, 2 parts corn and 1 part wheat.

‡ Hay very poor, not meadow.

§ A mixture of 1 part corn ensilage and 1 part oat and pea ensilage.

Condensed Milk.

The analysis of a large proportion of the brands of condensed milk for sale in this State shows that for the most part a good quality of milk has been used by the manufacturers for this purpose. In a few instances, however, skimmed milk has evidently been used. This is clearly indicated by the low percentage of fat in the last few samples

in the accompanying table, in which the samples are arranged in the order of their fats. The ratio of fat to proteid of normal milk is something like 5 to 4, while in the last instance on the table it is shown as 1 to 5.

Condensed Milks.

Inspector's Number.	Brand.	Total Solids.	Water.	Total Sugar.	Proteids	Fat.	Ash.
2101A, . . .	Quaker, ...	75.95	24.05	54.24	8.54	11.40	1.77
8167g, . . .	Maine's Favorite, . .	70.35	29.65	50.71	6.95	11.21	1.[illegible]
24899, . . .	Quaker, ...	70.80	29.20	50.10	8.00	11.10	1.60
9611g, . . .	Gold Medal, . . .	74.25	25.75	54.81	8.14	11.10	1.[illegible]
0297, . . .	Magnolia, ...	73.62	26.38	56.95	6.55	10.80	1.42
0295, . . .	Tip Top, ...	76.21	23.79	57.67	6.54	10.35	1.65
16092, . . .	Hampden, ...	70.16	29.84	49.22	9.00	10.35	1.86
24749, . . .	Hampden, ...	71.06	28.94	49.58	9.47	10.35	1.66
973A, . . .	Quaker, ...	73.85	26.15	52.02	9.94	10.20	1.69
2293A, . . .	Rival, ...	77.97	22.03	57.55	8.29	10.20	1.93
9837g, . . .	Quaker, ...	72.15	27.85	51.26	9.19	10.00	1.70
25154, . . .	Maine, ...	67.08	32.92	47.16	8.24	9.90	1.78
0296, . . .	Challenge, ...	73.27	26.73	56.23	5.61	9.90	1.53
25150, . . .	Rose, ...	75.69	24.31	55.47	8.67	9.90	1.65
7741g, . . .	Fern, ...	73.75	26.25	[illegible].67	5.74	9.74	1.60
1452A, . . .	Ten Cent, ...	73.40	26.60	54.78	7.44	9.60	1.58
9107g, . . .	Fern, ...	76.90	23.10	58.16	6.54	9.60	1.60
25151, . . .	Tip Top, ...	75.24	24.76	55.36	8.39	9.60	1.90
8274f, . . .	O. K., ...	75.45	24.55	55.36	8.24	9.60	1.75
24768, . . .	Rose, ...	70.10	29.90	[illegible].76	9.31	9.45	1.55
25148, . . .	Pine Tree, ...	68.45	31.55	48.58	8.56	9.48	1.83
8864f, . . .	Porcelain, ...	69.60	30.[illegible]	[illegible].24	11.34	9.30	1.72
24854, . . .	Defiance, ...	67.48	32.52	47.61	8.84	9.30	1.73
9361g, . . .	Clover, ...	64.75	35.25	46.36	7.69	9.30	1.40
8505g, . . .	Defiance, ...	68.00	32.00	49.82	7.33	9.28	1.57
25147, . . .	Gail Borden Eagle, . .	74.25	27.75	56.78	7.04	9.00	1.46
24788, . . .	Gail Borden Eagle, . .	73.55	[illegible].45	53.01	9.94	9.00	1.60
8635g, . . .	Fern, ...	79.90	20.[illegible]	61.28	7.84	8.90	1.90
24853, . . .	Fern, ...	77.73	22.27	59.24	8.24	8.70	1.55
24786, . . .	Maine, ...	70.10	29.90	51.63	8.29	8.70	1.48
24882, . . .	Peninsular, ...	70.75	29.[illegible]	50.64	10.04	8.40	1.67
24855, . . .	Challenge, ...	71.55	28.45	54.01	7.69	8.40	1.45
7882, . . .	Winthrop, ...	65.56	34.45	[illegible].97	10.74	8.25	1.59
8276f, . . .	Fern, ...	75.75	24.25	55.98	10.14	8.10	1.58

Condensed Milks — Concluded.

Inspector's Number.	Brand.	Total Solids.	Water.	Total Sugar.	Proteids	Fat.	Ash.
1943*h*, . . .	Porcelain, ...	74.48	25.52	53.75	8.01	8.10	1.62
24784, . . .	Tip Top, ...	73.42	26.58	54.57	9.11	8.10	1.64
24957, . . .	Dime, ...	71.77	28.23	53.80	8.66	7.68	1.63
25149, . . .	Baby, ...	69.30	30.70	50.30	10.06	7.35	1.59
24956, . . .	Porcelain, ...	73.08	26.92	53.52	10.54	7.20	1.82
9339*g*, . . .	Maine's Favorite, . .	68.95	31.05	49.95	10.70	6.90	1.49
9365*g*, . . .	Anchor, ...	67.70	32.30	47.46	11.42	6.90	1.92
9351*g*, . . .	Purity, ...	76.95	23.05	56.71	11.72	6.72	1.89
8072*f*, . . .	Maine's Favorite, . .	68.40	31.60	50.86	8.89	6.60	2.05
8649*g*, . . .	J. B. Smith, . . .	74.07	25.93	55.89	10.70	5.88	1.80
1007*h*, . . .	Winthrop Jersey, . .	67.23	32.77	50.77	11.03	3.50	1.93
3291*h*, . . .	Cape Ann, ...	67.40	32.60	48.51	14.19	2.70	2.00

The so-called evaporated cream proves in most instances to be an ordinary grade of milk, evaporated to the consistency of cream without the addition of sugar. In one instance, however, as shown in the accompanying table, an evaporated skimmed milk appears as the favorite brand of "evaporated *cream*."

Evaporated Creams.

Inspector's Number.	Brand.	Total Solids.	Water.	Sugar.	Proteids.	Fat.	Ash.
9343*g*, . . .	Borden's Peerless, . .	31.15	68.85	12.00	7.53	10.20	1.42
3845*g*, . . .	Imperial, ...	31.81	68.19	13.54	6.64	10.00	1.63
3407*h*, . . .	Superb, ...	30.73	69.27	12.76	6.63	9.90	1.44
1033*h*, . . .	St. Charles, . . .	28.62	71.38	10.03	7.04	9.90	1.65
25152, . . .	Highland, ...	29.93	70.07	10.74	8.73	9.00	1.46
21598, . . .	St. Charles, . . .	30.10	69.90	13.24	7.22	8.10	1.54
25153, . . .	Favorite, ...	22.14	77.86	3.97	14.62	2.25	1.30
7915*g*, . . .	Favorite, ...	21.46	78.54	-	-	1.58	1.21

In the analyses here reported, the total solids, proteids and ash were determined by methods described in our report for 1895.

The determination of the fat has been made by a special method devised by Mr. A. E. Leach of this laboratory. It is well known to those who have tried to apply the Babcock method of fat deter-

mination to condensed milks which are preserved by the addition of cane sugar, that it is impossible to accomplish the clean separation of the fat, on account of the heavy char resulting from the action of the sulphuric acid on the sugar. No degree of dilution obviates this difficulty. To get rid of the sugar before applying the Babcock method, the following scheme was devised. Forty grammes of the sample are weighed out, and its aqueous solution is made up to 100 cubic centimeters in a graduated flask. Fifteen cubic centimeters of this solution, corresponding to 6 grammes of the sample, are withdrawn by means of a pipette, and are transferred to one of the large test bottles commonly used for skimmed milk determinations in the Babcock centrifuge. The capacity of the body of this test bottle is about 50 cubic centimeters, and its neck is graduated to read as fine as 0.1 per cent. Water is then poured in till the liquid nearly reaches the neck of the bottle, and 3.5 cubic centimeters of an aqueous solution of sulphate of copper is added, of the strength of 69 28 cubic centimeters per litre (Fehling's copper solution). The bottle is then well shaken and its contents are allowed to settle. The precipitate, which consists of proteids, carrying with it the fat, subsides more quickly if the bottle is set in ice water. The clear supernatant liquid, which contains the sugar in solution, is then drawn off by means of a small-stemmed pipette, of a capacity of 50 cubic centimeters, whose upper end is fitted for convenience with a piece of rubber tubing. A small wisp of absorbent cotton is lightly twisted about the lower end of the pipette, to serve as a filter. After the liquid is thus drawn up into the pipette the cotton wad is removed from its lower end by lightly rubbing it against the inside of the bottle's neck as the pipette is withdrawn. The precipitate is washed three times as above by decantation, and then 25 cubic centimeters of sulphuric acid are added, and the usual Babcock centrifuge method is followed. The reading to tenths, multiplied by six, gives the percentage of fat in the sample.

Butter.

The inspectors have been unable to find any case of oleomargarine substitution during the year; 349 samples were examined.

Lard.

Of 67 samples, 18 proved to contain added cotton-seed oil or tallow.

Cheese.

No case of adulterated cheese has been found; 57 samples have been examined.

Olive Oil.

Of 33 samples, 10 were seed oil, either wholly or in part.

Honey.

Of 65 samples, 10 consisted wholly or in part of glucose syrup. The poorest sample contained 75 per cent. adulteration.

Molasses.

Of 137 samples, 12 contained glucose syrup. The maximum adulteration was 70 per cent.

Syrup.

All three of the refiners' syrups examined contained added glucose syrup.

Maple Sugar.

Of the 22 samples examined, 7 contained notable quantities of crude cane sugar.

Maple Syrup.

Of the 28 samples, 10 contained glucose syrup, or were chiefly sugar-house drips.

Ground Spices.

Allspice. — Of 129 samples, 6 were adulterated. The adulterants were ground fruit stones, wheat, ginger, nut-shells and peas. The worst specimen contained 40 per cent. of adulteration.

Cassia. — Of 250 samples, 7 were adulterated with ginger, wheat, sawdust and a foreign bark. The maximum adulteration was 50 per cent.

Cayenne again leads in respect of adulteration, 23 of the 67 samples proving to contain corn, wheat, turmeric, ginger or gypsum. The maximum adulteration was 50 per cent.

Cloves. — Of 235 samples, 10 were found adulterated with wheat, rice, allspice, ginger or clove stems. The maximum adulteration was 60 per cent.

Ginger. — Of 222 samples, 38 were found adulterated with corn or turmeric. The maximum adulteration was 70 per cent.

Mace. — Of 13 samples, 1 contained corn and turmeric.

Mustard. — Of 214 samples, 73 were found to contain turmeric, wheat, corn, buckwheat, rice, cayenne and potato. The maximum adulteration was 45 per cent.

Nutmeg. — Of the 12 samples examined, 1 contained wheat to the extent of 10 per cent.

Pepper. — Of the 337 samples examined, 22 were found to contain ground nut-shells, wheat, bark, ginger, olive stems or pepper hulls in large excess. The maximum adulteration was 65 per cent.

Vinegar.

As usual, the percentage of adulteration in vinegar stands higher than any other food of which as large a number of samples has been examined. Of the 83 specimens submitted, 41 were below standard. The following table shows the analysis of these samples in detail: —

Percentage of Acetic Acid.	Percentage of Solids.	Percentage of Acetic Acid.	Percentage of Solids.	Percentage of Acetic Acid.	Percentage of Solids.
6.05	2.00	4.77	2.70	4.52	2.26
5.75	2.95	4.75	1.88	4.52	3.76
5.70	0.40	4.74	2.00	4.52	1.83
5.60	2.40	4.74	2.66	4.50	2.50
5.55	1.94	4.72	1.45	4.50	3.12
5.38	2.64	4.69	3.14	4.50	2.52
5.35	2.00	4.69	2.15	4.48	2.20
5.34	2.60	4.68	2.00	4.47	2.55
5.28	1.76	4.68	2.00	4.47	2.65
5.23	1.83	4.68	2.14	4.47	2.60
5.06	2.84	4.66	2.79	4.43	2.00
4.97	0.55	4.66	2.00	4.43	2.20
4.95	3.92	4.65	2.60	4.40	2.30
4.92	2.00	4.65	0.40	4.39	2.00
4.92	2.02	4.65	2.07	4.37	1.10
4.90	2.02	4.63	2.77	4.34	2.36
4.90	2.00	4.62	0.00	4.30	1.13
4.90	0.44	4.62	2.20	4.30	2.30
4.90	2.57	4.56	0.60	4.15	3.70
4.89	0.00	4.55	0.37	4.15	0.55
4.88	1.67	4.55	2.28	4.00	0.57
4.87	1.84	4.55	2.10	3.90	0.00
4.85	2.22	4.55	2.86	3.89	1.59
4.83	0.30	4.54	3.74	3.80	1.14
4.80	3.10	4.54	2.77	3.70	4.67
4.80	2.46	4.53	2.04	3.41	1.20
4.80	3.60	4.53	0.00	2.96	2.35
4.79	0.64	4.53	2.75		

TEA.

Of 96 samples examined, only 1 proved to be adulterated.

COFFEE.

Of 120 samples examined, 16 were adulterated with chiccory, peas, wheat, dandelion, beans, sticks or gravel. The maximum adulteration was 70 per cent.

COCOA (*including Chocolate Preparations*).

Of 39 specimens submitted, 9 of the samples of cocoa proved to be adulterated with rice, wheat, sugar, salt, oatmeal, arrowroot or potato. The sample containing the largest admixture showed but 44 per cent. of cocoa.

CONFECTIONERY.

Of 126 samples examined, only 3 were found to contain elements not properly edible. These were samples of chocolate lozenges, containing no chocolate, but colored with considerable addition of oxide of iron.

CREAM OF TARTAR.

Of 421 samples examined, 17 proved to be adulterated with corn, alum, gypsum or acid phosphate of lime. The poorest sample contained 70 per cent. of gypsum.

CANNED GOODS (*exclusive of Condensed Milk*).

Of canned goods, 47 samples were examined for metallic poison. Notable quantities of lead have not been found, and only 3 samples contained tin in injurious amount.

MISCELLANEOUS.

Of 190 samples classed under this head, 49 proved to be adulterated, or to contain injurious ingredients.

Among these samples were specimens of pickles, none of which were found to contain copper; of chowchow, which proved to contain salicylic acid, as also did samples of catsup and apple butter.

Samples of tripe and oysters were found to be preserved with boracic acid, and a sample of so-called "preservative" was found to consist of boracic acid.

Samples of extract of vanilla were found to be largely reinforced with coumarin.

Samples of "currant jelly" were found to consist of apple jelly colored with cochineal.

Samples of tin foil used to wrap fresh cheeses and sausages were examined. The only sample which proved to contain more than 3 per cent. of lead, which is considered the danger limit in foil used for this purpose, was one in which was wrapped a cheese from Worcester County Creamery. This was a bright foil, in contrast to the dull foil used to wrap Neufchatel and cream cheeses. This specimen contained 52.8 per cent. of lead.

Samples of sausages were found to be colored artificially.

Summary of Food Statistics.

Foods.	Genuine.	Adulterated.	Total.	Per Cent. of Adulteration.
Allspice,	129	6	135	4.4
Butter,	349	0	349	0.0
Canned goods,	44	3	47	6.4
Cassia,	243	7	250	2.8
Cayenne,	44	23	67	34.3
Cheese,	57	0	57	0.0
Chocolate,	30	9	39	23.0
Cloves,	225	10	235	4.3
Coffee,	104	16	120	13.3
Confectionery,	123	3	126	2.4
Cream of tartar,	404	17	421	4.0
Ginger,	184	38	222	17.1
Honey,	55	10	65	15.3
Lard,	49	18	67	26.8
Mace,	12	1	13	7.7
Maple sugar,	15	7	22	31.8
Maple syrup,	18	10	28	35.7
Miscellaneous,	141	49	190	25.8
Molasses,	125	12	137	8.8
Mustard,	141	73	214	34.1
Nutmeg,	11	1	12	8.3
Olive oil,	23	10	33	33.3
Pepper,	315	22	337	6.5
Syrup,	0	3	3	100.0
Tea,	95	1	96	1.0
Vinegar,	42	41	83	49.4
Totals,	2,978	390	3,368	11.6

Drugs.

Samples which do not conform with pharmacopœial requirements are here reported adulterated, or of poor quality.

Acetanilid: Of 21 samples examined, only 1 proved to be adulterated; it was found to contain corn.

Acidum Benzoicum: Of 6 samples examined, all were of good quality.

Acidum Hydrobromicum Dilutum: Of 7 samples examined, all were of good quality.

Acidum Tannicum: Of 5 samples examined, all were of good quality.

Æther: Of 22 samples examined, 4 were of poor quality, containing too much alcohol and water.

Alcohol: Of 14 samples examined, 4 contained too much water.

Aqua Ammoniæ: Of 7 samples examined, 3 were of poor quality, containing insufficient NH_3.

Aqua Chlori: None of the 3 samples examined contained anywhere near the required amount of chlorine.

Aqua Destillata: Of 30 specimens, 25 were of poor quality. But very little care appears to be exercised by druggists to insure a good quality of this simple preparation. The subjoined figures will show the quality of the specimens examined. A pure distilled water of course contains no solid residue. The following figures indicate the parts of solid residue found in 100,000 parts of each sample: —

72	12	8	7	5	2.5	0
30	11.5	8	6.5	4.5	2	0
27	10	7	5.5	4.5	1	0
14.5	10	7	5.5	4.5	0	0
12	9	7	5.2			

Aqua Hydrogenii Dioxidi: The single specimen examined seemed to be of pharmacopœial strength.

Argenti Nitras: Of the 16 samples examined, all were of good quality.

Bismuthi Subcarbonas: Of the 7 samples examined, all proved of good quality.

Bismuthi Subnitras: Of the 27 samples examined, 3 failed to meet the pharmacopœial requirements, containing traces of arsenic or notable amounts of subcarbonate.

Calx Chlorata: Of the 5 samples examined, none were of good quality, the amount of available chlorine being in one case but 5 per cent. of the requirement.

Calx Preparata: The 2 samples examined proved to be of good quality.

Cerii Oxalas: The 6 samples examined proved to be of good quality.

Chloral Hydras: The single sample examined proved to be of good quality.

Chloroformum: Of the 11 samples examined, 2 were of poor quality, containing too much alcohol.

Extractum Glycyrrhizæ: Of the 8 samples submitted, 7 proved to be adulterated with corn starch.

Extractum Nucis Vomicæ: All of the 3 samples examined were of insufficient strength, the percentage of total alkaloids being respectively 11.28, 10.92, 9.10.

Glycerinum: Of the eight samples examined, all were of good quality.

Hydrargyri Chloridum Mite: Of the 22 samples examined, all were of good quality.

Oleum Limonis: Of 10 samples examined, 4 were of poor quality, containing alcohol.

Paraldehydum: The single sample examined was of good quality.

Phenacetin: The two samples examined were of good quality.

Pulvis Opii: Of the 31 samples examined, 16 were not of pharmacopœial strength. The following figures show the percentage of morphine contained in the various samples: —

25.5	14.99	14.30	14.10	14.00	13.40	13.20	10.40
16.14	14.92	14.30	14.00	13.90	13.40	11.42	6.80
15.7	14.90	14.20	14.00	13.70	13.30	11.40	3.55
15.4	14.70	14.10	14.00	13.70	13.30	10.76	

Spiritus Ætheris Compositus: Of the 32 samples examined, only 7 proved of standard quality; 1 consisted chiefly of amyl alcohol, and the others contained little and in most cases no ætherial oil.

Spiritus Ætheris Nitrosi: Of the 13 samples examined, only 4 approximated the standard.

Spiritus Frumenti: Of the 13 specimens submitted, only 2 approached the standard requirements. The following table shows the results of analysis: —

Percentage of Alcohol by Weight.	Percentage of Solids.	Percentage of Alcohol by Weight.	Percentage of Solids.	Percentage of Alcohol by Weight.	Percentage of Solids.
44.18	0.00	40.70	1.20	37.78	0.70
43.52	0.65	39.80	0.66	37.11	1.50
43.14	0.70	39.00	1.00	35.50	0.66
42.95	0.23	38.22	0.20	31.62	0.46
42.29	0.79				

Spiritus Juniperi: The single sample examined proved to contain too much water.

Spiritus Vini Gallici: Of the 2 samples examined, 1 was of poor quality.

Succus Limonis: Of the 2 samples examined, 1 was of poor quality, containing insufficient citric acid.

Syrupus: Of the 25 samples examined, 17 contained insufficient sugar.

Tinctura Iodi: Of the 43 samples submitted, only 6 contained the required amount of iodine. The percentage of pharmacopœial requirement of iodine which these samples respectively contained is shown by the following figures: —

100	100	92	87	85	80	75	70	50
100	95	90	87	85	78	74	68	50
100	94	90	87	83	77	72	68	25
100	93	90	86	82	75	70	68	
100	92	88	85	80	75	70	67	

Tinctura Opii: Of the 58 samples examined, only 15 contained the required percentage of morphine. The respective percentages of morphine of these samples is indicated by the following figures: –

2.02	1.33	1.16	1.09	1.03	0.93	0.88	0.45
1.51	1.27	1.16	1.09	1.03	0.93	0.85	0.18
1.50	1.27	1.15	1.08	1.02	0.92	0.85	
1.49	1.25	1.15	1.06	1.00	0.92	0.84	
1.49	1.22	1.12	1.06	0.99	0.91	0.76	
1.48	1.22	1.12	1.04	0.99	0.91	0.72	
1.43	1.21	1.11	1.04	0.97	0.90	0.56	
1.37	1.17	1.09	1.03	0.96	0.89	0.51	

Very many of these samples did not bear the red poison label and printed antidote directions, as required by statute.

Unguentum Hydrargyri: Of 8 samples examined, only 1 fulfilled the requirements of the pharmacopœia. The poorest specimen contained about half the requisite amount of mercury.

Vinum Album: Of 5 specimens examined, all were below the pharmacopœial standard, containing much added sugar.

Vinum Rubrum: Of the 12 specimens examined, all were below the standard. One specimen contained as much as 22.5 per cent. of solids, chiefly added sugar.

Miscellaneous.

Of 15 samples under this head, 5 were of poor quality.

In this class were included samples of face lotions, containing rose water, oxide of zinc, subcarbonate of bismuth, calomel, a trace of lead, salt, bay rum, prepared chalk, tincture of benzoin and a trace of corrosive sublimate.

Samples of sarsaparilla extract were examined, with the result of finding alcohol in the amount indicated in the accompanying table: —

Commercial Name of Sarsaparilla Extract.	Percentage of Alcohol (by Weight).
Ayer's Sarsparilla,	21.00
Thayer's Compound Sarsaparilla,	17.50
Paine's Celery Compound,	17.00
Hood's Sarsaparilla,	15.25
Green's Nervura,	14.00
Allen's Compound Sarsaparilla,	10.92
Dana's Sarsaparilla,	10.92
Brown's Sarsaparilla,	10.85
Corbett's Shaker Sarsaparilla,	7.04
Radway's Renovating Resolvent,	6.36
Moxie,	–*

* Mere trace.

The essential element of "Go to Sleep" was found to be sulphonal.

A face powder was found to consist of corn starch.

A so-called "Whiskey Salt" consisted of crude sodium carbonate.

A cleaning preparation called "Cuticlene" consisted essentially of corn meal, soap and nitro-benzol.

A sample of carbon dioxide gas, supplied in cylinders for soda fountain use, was found to contain 1.2 per cent. of air.

Summary.

	Genuine.	Adulterated.	Total.
Milk,	2,754	1,499	4,253
Food not milk,	2,978	390	3,368
Drugs,	251	254	505
Total,	5,983	2,143	8,126

Respectfully submitted,

CHARLES P. WORCESTER.

WESTERN MASSACHUSETTS.

Comment has already been made, in previous reports, upon the superior quality of the milk furnished to consumers in the western counties of Massachusetts, as compared with that which is furnished to the population of the eastern part of the State. Two conditions or circumstances probably explain this fact. These conditions are very similar in character: —

First, the Density of Population. — In the four western counties the mean density of population, according to the census of 1895, was but little more than one-fourth as great as that of the remainder of the State, the exact ratio being as 116 to 399 (persons to the square mile). Other things being equal, adulteration of milk is more prevalent in densely settled than it is in sparsely settled districts. In densely settled districts the milk supply is derived largely from places at a considerable distance, and adulteration is more common in proportion to the distance of the producer from the consumer, and also to the time which elapses between production and consumption. In the cities and towns of the western counties the milk is produced within a few miles of the consumer, and is, therefore, of better average quality.

Second, Supply and Demand. — While the conditions of supply and demand are partially dependent upon seasons of the year, they are also closely connected with and dependent upon the former condition, — the density of population.

During the fourteen years which have elapsed since the food and drug acts went into operation, the Board has extended to the four western counties its regular and continuous inspection, in like manner with the eastern portions of the State; and, while the number of samples of milk inspected from this district has not been so great in proportion to the population at that of the eastern portion, it has been quite as great as the relative prevalence of adulteration in the two districts would seem to require.

The following is the list of cities and towns from which such samples of milk have been obtained, from 1884 to 1896 inclusive : —

Springfield.
Holyoke.
Northampton.
Chicopee.
Pittsfield.
North Adams.
Adams.
Greenfield.
Amherst.
Palmer.
West Springfield.
Montague (Turner's Falls).
Ware.
Westfield.
Lee.
Lenox.
Orange.
Shelburne.
Great Barrington.
South Hadley.
Deerfield.

The whole number of samples, and the number obtained in each year, together with the number found to be below the standard, are indicated in the following table : —

Years.	Samples of Milk.	Number below Standard.	Years.	Samples of Milk.	Number below Standard.
1884, . . .	163	52	1892, . .	252	50
1885, . . .	281	49	1893, . .	187	38
1886, . . .	126	25	1894, . .	183	39
1887, . . .	219	23	1895, . .	245	60
1888, . . .	299	47	1896, . .	157	27
1889, . . .	300	53			
1890, . . .	270	61	Totals, .	3,008	584
1891, . . .	326	60			

The whole number of samples was 3,008, and of these 584, or 19.4 per cent., were not of standard quality.

This percentage (19.4) was less than half as great as that of samples taken in the eastern part of the State during the same time. It should, however, be stated that the conditions prevailing in the two districts are not exactly comparable, since a considerable number of the adulterated samples included in the total of those taken in the eastern counties was comprised of samples taken from suspected producers, and this class of samples usually presents a very high ratio of adulteration ; while the demand for this line of inspection in the western counties has practically amounted to nothing, for the reason that the conditions of supply and demand have been such as

to present comparatively little inducement to fraud on the part of the producer. Still, if this class of samples were to be entirely eliminated from the comparison, there would still remain a very decided difference in the average quality of the milk furnished to consumers in the two districts.

The total number of prosecutions of offenders against the milk laws in this district during the period in question was 21, or an average of only 1½ per year. Of this number, 16 resulted in conviction.

PROFESSOR GOESSMANN'S REPORT.

The whole number of samples of milk collected in the counties west of Worcester County during the year was 157, and the number found below the standard was 27, or 17.2 per cent. This is a lower ratio than that of any year since 1888, but this result is partly due to the change in the standard in certain months, as stated on a previous page.

The following summary embraces the samples of milk obtained during the year in cities and towns west of Worcester County.

The results of analyses were as follows: —

Whole number examined,	157
Number above standard,	130
Number below standard,	27
Percentage below standard,	17.2
Number samples skimmed milk,	9

Chicopee.

Number of samples,	20
Number above standard,	18
Number below standard,	2
Percentage below standard,	10.0
Skimmed milk,	0

North Adams.

Number of samples,	17
Number above standard,	17
Number below standard,	0
Percentage below standard,	0
Skimmed milk,	0

Springfield.

Number of samples,	79
Number above standard,	63
Number below standard,	16
Percentage below standard,	20.3
Skimmed milk,	5

The results in the towns were as follows: —

	Total.	Above Standard.	Below Standard.	Percentage below Standard.
Greenfield, ...	24	21	3	-
Westfield, ...	17	11	6	-
	41	32	9	22.0

CHARLES A. GOESSMANN.

A COMPARATIVE STUDY

OF THE

TOXIN PRODUCTION OF DIPHTHERIA BACILLI.

BY

THEOBALD SMITH, M.D., AND ERNEST L. WALKER.

1897.

INTRODUCTION.*

By THEOBALD SMITH, M.D.

This inquiry was suggested by the following important problems bearing upon the restriction of diphtheria: —

1. Is there any difference in the pathogenic power of diphtheria bacilli from different localities?

2. Is the pathogenic activity of bacilli producing diphtheria in the summer season different from that of those producing disease in winter?

3. Is there any reduction in the pathogenic power of bacilli in cases in which they persist in the throat after recovery?

4. Are there any differences noticeable between the bacilli of mild and those of severe cases?

The third and the fourth questions have been attacked by other observers, while the first and the second have not been especially investigated. The answers to the third and the fourth questions have been, as a rule, negative. Observers have found little or no difference in bacilli from mild and severe cases, nor have they been able to show any recognizable loss of virulence in the bacilli persisting in the throat after recovery.

The reasons for entering upon this subject again were the opportunity we have had of examining cultures from different towns within the State, and more especially certain improved methods of cultivation by which the maximum toxin-producing capacity of each bacillus could be brought out and measured more accurately than had been done heretofore.

The selection of cultures for the study of the questions stated above has not been entirely satisfactory, mainly because much of the clinical information necessary to a proper choice was not accessible

* The writer wishes to acknowledge the faithful assistance of J. R. Stewart, to whom the preparation of the culture media was chiefly entrusted. As will be seen from what follows, this is not a simple task.

at the time the cultures were received, and in some instances obtainable only with difficulty at the last moment when the final results were tabulated. We hope, however, that the material at hand may be supplemented by more in the near future.

The Mode of Action of Diphtheria Bacilli.

It is now a generally accepted theory that diphtheria bacilli act in the main through the toxins which they produce, and which are rapidly diffused into the fluids containing the vegetating bacilli. The contents of the bacilli themselves seem to be of little moment as pathogenic factors. Park and Williams * allowed the washed diphtheria bacilli to soak for a week "in a 0.5 per cent. alkaline carbolic solution." The injection of one cubic centimeter did not "produce any marked reaction in a 500-gramme guinea-pig," although the bacilli themselves were powerful toxin-producers. Kossel † collected the bacillar membranes from cultures, washed the bacilli repeatedly by centrifugalizing with 0.5 per cent. sodium chloride; then, after killing them with vapors of chloroform, he extracted them for several days in a few cubic centimeters of weakly alkaline fluids. The extract was only feebly poisonous, for it required 5 cubic centimeters to kill a 360-gramme guinea-pig in forty-eight hours.

Brieger and Boer ‡ found that shaking diphtheria bacilli with ammonium chloride and allowing them to stand for eighteen to twenty hours removes the toxin from the bodies of the bacilli. The bacilli after extraction were fatal to a 500-gramme guinea-pig, in doses of 0.01 gramme of bacillar substance. They acted by producing local necrosis. Brieger states that antitoxin had no effect upon this action of the dead bacilli, and that immunization towards it by gradually increasing doses failed. The poison itself withstood an hour's boiling.

These experimental observations, taken together, show that the toxin in the culture fluid and not the body substance of the bacilli themselves is to be looked upon as the disease agent. The success following the prompt application of antitoxin in sufficient doses is an additional support to this view. Moreover, the bacilli themselves do not penetrate into the body in large numbers, hence need not be specially considered as adding to the toxic effect of their products.

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* "Journal of Exp. Med.," I., page 174. † "Centralblatt f. Bakteriologie," XIX., page 977.
‡ "Deutsche Med. Wochenschrift," 1896.

We may, for convenience, regard the disease-producing power of diphtheria bacilli as made up of two elements, — toxicity and virulence. The former represents the rate of accumulation of toxin in culture fluids, and is easily measured; the virulence, on the other hand, which may be regarded as the behavior of diphtheria bacilli toward living tissue, is as yet an unknown quantity. This distinction between the toxic product of diphtheria bacilli and their inherent vital power to cope with living tissue seems to be established, at least experimentally, by the increase in virulence of diphtheria bacilli in their passage through a series of guinea-pigs, which has been reported by various observers. Thus, Aronson * states that a culture which was at first fatal to guinea-pigs of medium weight, in 0.1 cubic centimeter doses, was fatal, after some serial inoculations, in doses of 0.008 cubic centimeter. That is to say, its virulence was augmented twelve times. This experiment evidently means not that the toxin formed in the sub-cutis of guinea-pigs became twelve times stronger in quality at the end of the series, but that the bacilli injected were capable, by an adaptation of some sort, to multiply much more abundantly toward the end of the series, and hence produce more toxin. The other explanation, that the toxin itself had become more potent in quality, could only gain confidence if the bouillon culture produced much more toxin at the end of the experiment than at the beginning, the conditions remaining precisely the same.

To compare the disease-producing power of diphtheria bacilli from different sources, it was, therefore, thought best to study the relative accumulation of toxin in bouillon, and eliminate the bacilli by filtration before the test upon animals. The writer is fully aware of the fact that but an instrument of pathogenic power is here dealt with, and under artificial conditions, since we do not know the nature of the nutritive fluid which the bacilli make use of on mucous membranes, nor, as a consequence, whether the toxin production in bouillon is a true index of the production of toxin on mucous membranes. The problem is, in fact, very complex, as with all infectious diseases, and all we can hope to do at a time is to examine one factor of disease as carefully as possible, while eliminating all the others for the time being. The use of living cultures upon animals is of no service in these experiments, because it introduces at once three variable factors: (1) the bacilli as potential toxin-producers after

* "Berl. klin. Wochenschr.," 1893, Nos. 25 and 26.

injection; (2) the poison of their bodies after destruction; and (3) the toxin pre-formed in the culture fluid injected. As a consequence, all who have used cultures find them uncertain in their action, as compared with the toxin alone. The bacilli injected as nearly free from fluid as possible are equally unreliable as measures of toxicity, as the following tests show: —

Two cultures of diphtheria bacilli are selected, which differ considerably in toxin-producing power, as is shown in Table I., where the toxin-producing power of one (No. 14) is about three times that of the other (No. 40). Inclined agar cultures are prepared from each, and after six days' growth the bacilli are removed with a platinum wire, the amount of moist bacilli weighed and stirred in 5 cubic centimeters sterile bouillon, making a moderately cloudy suspension. One cubic centimeter contained by weight about 0.0007 grammes of moist bacilli.

Bacillus No. 14. — Five-tenths cubic centimeter of the suspension, injected subcutaneously into a guinea-pig weighing 313 grammes, is fatal in five days; 1 cubic centimeter is fatal to a 330-gramme pig in six days.

Bacillus No. 40. — Of the suspension made in the way described, 1 cubic centimeter is injected into a guinea-pig weighing 315 grammes. Animal just escapes death, and is chloroformed on the sixth day. Another, weighing 330 grammes, receives 0.5 cubic centimeter. A slough forms at the place of injection. The guinea-pig remains in fair condition.

Though these tests show a greater activity on the part of Bacillus No. 14, yet we miss here not only the sharp definition in the results obtained by varying the dose of the same culture, but also in comparing the effect of the same doses of cultures from different sources.

A prolonged study of the relative production of toxin in bouillon under certain uniform conditions has shown such remarkably uniform results with the same culture, even after long intervals of time, that the results obtained in this way may be accepted as showing an inherent difference in the various bacilli studied.

THE METHOD EMPLOYED IN COMPARING THE TOXIN PRODUCTION OF DIFFERENT CULTURES.

In a former publication* the writer has given the conditions which must be fulfilled in order that a maximum accumulation of toxin may take place in bouillon cultures. The facts there considered and

* "Trans. Association American Physicians," for 1896.

others since then brought out may be very briefly reviewed here. In 1895 Spronck * called attention to the fact that the variable amount of sugar present in beef was responsible for the great fluctuations observed in the toxicity of diphtheria cultures. The writer had observed this independently of Spronck, by studying the relation between the amount of toxin in cultures and the amount of sugar as determined by the fermentation test. Sugar is present in all beef, but in perhaps 10 per cent. the amount is very small. In bouillon made from such beef the writer obtained very strong toxin. In bouillon from beef containing over 0.1 per cent. sugar the toxin was very feeble.

The cause for this difference lies in the acid or acids formed from the dextrose by the diphtheria bacillus, which inhibit the multiplication in a direct ratio to the amount formed. In sufficient quantity the growth may be entirely checked, and finally, when the acidity has reached a certain degree, the bacilli and the toxin are destroyed. Whether there are other causes at work besides mere inhibition of multiplication remains undetermined.

A small amount of dextrose, up to 0.05 per cent., is not inimical to toxin production; in fact, it seems to be more favorable than none at all, probably because a certain minimum amount is necessary for the cell life of the diphtheria bacilli. Bearing these facts in mind, we are better able to comprehend the various changes going on in cultures. The life of the culture begins with a rapid multiplication of the bacilli introduced and the formation of a surface membrane usually within twenty-four hours. At the same time, any sugar present is acted upon at once, with the result that the reaction becomes more acid. If the acidity increases beyond 2 per cent. of a normal acid solution,† the culture is likely to become languid, the surface membrane rifted and settle to the bottom. Some bacilli, by a vigorous surface growth which probably oxidizes the acid products formed, may subdue a larger amount of acid, even to 3.5 per cent., and cause a rapid return towards the alkaline level. The toxin appears in greatest concentration when the alkaline level has been reached, usually within eight to twelve days when sugar is present in small amount only. When sugar is more abundant the acid period is prolonged, during which little growth is evident. After

* "Annal. de l'Institut Pasteur," 1895, page 758.

† *I. e.*, each 100 cubic centimeters of the culture fluid requires 2 cubic centimeters of a normal solution of alkali to bring the whole to the neutral point as determined by phenolphthalein.

several weeks a slow alkalizing tendency brings the culture to a more vigorous growth and to an alkaline reaction, but without much accumulation of toxin.

Without going into more detail on this subject, we may summarize the conditions under which diphtheria bacilli produce maximum amounts of toxin in the ordinary 1 per cent. (Witte) peptone bouillon as follows: —

1. Muscle sugar in the fluid from 0 to 0.05 per cent.
2. Initial reaction from 0.8 to 1.5 per cent. normal acid, the lower figure pertaining to bouillon containing the largest amount of sugar, the higher to bouillon containing none.
3. A thin layer of bouillon freely exposed to the air through one or more cotton-plugged openings in the vessel, and quiescent because the surface membrane which forms within twenty-four hours must not be disturbed.
4. The accumulation of toxin should be permitted to go on until the growth is checked by the alkaline reaction. This appears in from eight to twelve days, according to the initial reaction and amount of sugar present, and the growth ceases when the reaction is equivalent to 0.2 to 0.3 per cent. normal alkali.

The main difficulty before us, therefore, is to get beef containing only traces of dextrose. The writer's original plan, to select the bouillon in accordance with the fermentation test, is not feasible, because so little can be used. Spronck's suggestion, to allow the beef to lie for several days, in order that a partial decomposition by bacteria may transform the sugar, is better, but suffers from certain difficulties. The kind of bacteria cannot be controlled, and frequently the sugar is found but partially removed. Latterly, the writer has given up this method for one more rapid and certain in its action. The beef infusion is prepared either by extracting the chopped beef at 60° C. for several hours, or over night in the refrigerator. After removal of the beef the infusion is inoculated with a culture of some bacterium which rapidly acts upon dextrose, and placed in the thermostat over night. The writer has tried only B. coli, and found a complete transformation of carbohydrates taking place over night.

In the case of bouillon designed for diphtheria toxin the incubation should be as short as possible, so as to leave a trace of sugar in the fluid. This can be accomplished by placing the inoculated infusion in the thermostat at 10 P.M. and removing early next morn-

ing (8 A.M.). The infusion is then made up in the usual way, with 1 per cent. peptone, ½ per cent. sodium chloride. The final reaction should range, according to the amount of sugar left as stated above, between 0.8 and 1.5 per cent. normal acid, phenolphthallein being used as indicator. It can easily be brought to any desired point by adding from sterile solutions the calculated amount of normal acid or alkali (HCL or NaHO). The whole procedure is very simple after it has been put into routine practice. At any rate, the bacteriologist must make up his mind to give up the early slovenly methods of preparing culture media, or else be prepared for constant reverses and failures.

The bouillon must be sterilized finally in the autoclave, since the ordinary steaming frequently fails to destroy certain spore-bearing anaërobes, which begin to multiply after the diphtheria bacilli have formed a membrane and deoxidized the culture medium. These anaërobes inhibit the production of toxin.*

Park and Williams claim † that the amount of dextrose in beef purchased in New York City is not sufficient to interfere with the maximum accumulation of toxin if the culture be made sufficiently alkaline to begin with. This claim I cannot support by my experience with beef bought in the Boston markets. It may be that these authors had under observation bacilli which had acquired, through surface cultivation, a greater power to promptly oxidize acid products. This power is not possessed, as a rule, by bacilli recently isolated from the throat, with which this article deals.

A number of observers have published studies of the relative virulence of diphtheria bacilli from various sources, and those persisting in the throat after recovery for a variable length of time. It is not the object of this article to re-examine these writings and review the results obtained. For a summary of the literature the reader is referred to the article by J. H. Wright in the "Boston Medical and Surgical Journal," Vol. 131 (1894), page 329, and "Scientific Bulletin" No. 1 of the health department, city of New York (1895). A perusal of the various articles will show that the method of testing the virulence of the diphtheria bacilli was not adapted to give uniform or quantitative results. Thus, Park and Beebe, on page 23 of the

* Since writing this, it has been observed that high temperatures in the autoclave may modify the bouillon in such a manner that only little toxin is formed subsequently. This matter is now under investigation.

† "Journal of Experimental Medicine," I. (1896), page 164.

bulletin referred to, recommend alkaline glucose bouillon as a culture medium, and the injection of cultures forty-eight hours old. Wright used sugar bouillon very largely. From what we now know of the inhibitory and destructive action of the acids formed from dextrose by diphtheria bacilli, the use of more than 0.1 per cent. dextrose in bouillon must be considered as at least unsafe. However, the authors followed general usage at that time, for even Escherich, in his work on diphtheria issued in 1894 (page 91), states that dextrose is not decomposed in appreciable manner by diphtheria bacilli, and therefore has no influence on growth.

Authors have not, so far as the writer knows, reported comparative tests of toxin production under conditions as nearly uniform as possible. It was mainly to fill this gap, if possible, that the series of cultures to be described were subjected to a comparative examination from the point of view of toxin production. Table I. gives a condensed account of the work done upon which the calculation of toxin production rests. In this table will be found: (1) the amount of acid produced in dextrose bouillon; (2) the condition of the bouillon used for the cultures; and (3) the test of the filtrate on guinea-pigs. The acid production will be dealt with farther on. The facts relative to the bouillon used need some explanation.

The beef used for bouillon, with one exception, was allowed to decompose according to Spronck's suggestion, but the results were not uniform, as stated above. In some of the bouillon the dextrose was absent, in some present in traces, in some in more appreciable amount, according to tests made with the fermentation tube and B. coli. In none was it present in the amount usually found in bouillon made from fresh beef. It is not probable that this slight fluctuation in the amount of dextrose had any appreciable influence on the culture. Where a doubtful result was obtained it was usually supplemented later on with a second test.

The question might be asked, Why not use the same bouillon for all bacilli studied, in place of the many lots actually employed? This would seem the simplest procedure, provided the bouillon did not change with time under the influence of light and air. A diminution in the amount of toxin produced in bouillon which had been standing for some time in a closet not absolutely dark had been casually observed. It is probable that bouillon in vacuo and kept in a dark place might meet the conditions of the problem, but bouillon kept under ordinary conditions would not. Further investigations

are now in progress to determine more precisely the degree of change produced in bouillon by age.

It might be claimed that different bacilli isolated from the throat would have different rates of growth in bouillon, and that the accumulation of toxin was simply a factor of the rate of multiplication, rather than of any inherent differences in the physiology of the bacilli. To answer this claim a determination of the number of diphtheria bacilli in cultures is not trustworthy, for the reason that diphtheria bacilli clump together, and the number of colonies in plate cultures may not indicate the number of bacilli used in preparing the plate. Again, bacilli may die in the course of growth, and others take their places. The writer has therefore endeavored to estimate the vigor of growth by the amount of change in the reaction produced. Cultures which in a given time in the same bouillon produce nearly the same amount of alkali may be regarded as having performed the same amount of work and grown with equal vigor. The uniformity of reaction in the various groups of bacilli studied together, after ten or twelve days, was such as to leave little doubt that the growth had been equally vigorous. When any culture lagged perceptibly behind, it was usually repeated with other bouillon.

The extent of the alkali production varies with the initial reaction of the bouillon and the presence of dextrose. Cultures containing the latter became at first more acid before swinging back to alkalinity. In Table I., therefore, it was deemed best to give both the initial reaction of the bouillon, the approximate amount of dextrose and the final reaction. Some idea may thus be gained of the amplitude of change which the fluid underwent during the period of growth permitted.

The culture vessel used at first was a large test tube placed in an inclined position after inoculation. This was soon given up for the Erlenmeyer flask, in which the depth of the bouillon was about 1.5 centimeters.

The toxin formed after ten to twelve days was tested upon guinea-pigs. The fluid was passed through filter paper until clear, then diluted with sterile salt solution, so that the quantity of toxin injected was contained in 1 cubic centimeter. Usually 0.1 cubic centimeter of toxin was injected. The place of injection chosen was the left side of the abdomen. Great care was exercised to deposit the fluid in the subcutis, and not to prick the muscles of the abdominal

wall. A vascular injection of the omentum or peritoneum is usually a result of the introduction of some of the fluid into the abdomen. When such reddening was noted at the autopsy, the test was repeated upon another animal, since death is hastened somewhat when this occurs. Guinea-pigs weighing between 300 and 350 grammes were used whenever possible. When larger ones had to be used, the increase in weight was duly taken into account.

From the results of such inoculations the minimum fatal dose upon a guinea-pig weighing 300 grammes was calculated. The calculation when such had to be made was based upon the fact that the minimum fatal dose usually kills a guinea-pig in from three and one-half to six days. If x represents this dose, then a guinea-pig which succumbed in two and one-half days, or sixty hours, received $\frac{10x}{9}$, and one which succumbed in thirty-six hours, $\frac{20x}{9}$. Guinea-pigs of greater weight do not necessarily bear an exact equivalent increase of toxin, but usually somewhat less. In general, it may be said that the values given as the minimum fatal doses may err within 10 per cent., owing to various factors which cannot be controlled. Among these is a slight variation among guinea-pigs in their tolerance of the virus, the darker (black, or black and red) animals being able to stand about 10 per cent. more toxin than the white animals. Even if we allow a variation of 10 per cent. in the values given in Table I., the general outcome of the comparative study is not made in any sense untrustworthy.

Comparative Study of Forty-two Cultures of Diphtheria Bacilli and of Four Cultures of Pseudo-Diphtheria Bacilli from Different Localities in Massachusetts.

By Theobald Smith and E. L. Walker.

Morphology.

The following description of the morphology and the staining peculiarities of the bacilli studied is based on microscopic preparations from cultures of twenty-four hours' growth at 35° to 37° C. on Löffler's blood-serum mixture, uniformly fixed and stained. The cover-slip preparations were dried in open air at room temperature, fixed by heating twenty minutes in a dry-air sterilizer at the temperature of 120° C., and stained eight minutes with Löffler's alkaline methylene blue solution. It may be remarked, however, that experiment shows that the method of fixation has little if any effect on the outline of the bacillus or upon the aggregation of its chromatin, and consequently upon the irregularity of its staining.

In length the diphtheria bacilli vary from 1.5 μ to 13 μ, and for the purpose of description it is convenient to distinguish three groups: short bacilli, including all bacilli under 2 μ in length; bacilli of medium length, including all bacilli between 2 μ and 4.5 μ; and long bacilli, including all bacilli over 4.5 μ in length. Bacilli in culture No. 33 are rather remarkable for their length, averaging 7.5 μ to 10 μ, while a few were found as long as 13 μ.

It may be said of diphtheria bacilli in general that there appears to be a tendency for the shorter bacilli to become swollen at the middle and for the long bacilli to become swollen at the ends; and that the short bacilli are usually straight, while the long bacilli are usually curved or bent at an obtuse angle.

Comparison on the basis of length, outline and manner of staining allows the bacilli of the forty-two virulent cultures to be divided into three types, of which the following description may be given: —

Type I. — Bacilli of medium length, straight, cylindrical or slightly swollen in the middle, with blunt ends, and with intensely stained granules in an otherwise uniformly but less deeply stained cell. In the shorter bacilli of this type these granules are usually situated at the ends of the rod, one at each end; but in the longer bacilli there may be, in addition to these polar granules, one or more interpolar granules. These deeply stained bodies are usually of less diameter than the thickness of the bacillus, but may be of greater diameter, swelling the bacillus at the points where they are situated.

Type II. — Bacilli long, slender, curved, more or less swollen at one or both ends, and with alternating stained and unstained (or faintly stained) cross-segments.

Type III. — This includes seven of the forty-two cultures. Bacilli are of various lengths, swollen in the middle, with tapering ends, and with broad, unstained terminal and intermediate segments. These unstained terminal segments may be so extensive that a body simulating a nucleus in the middle of the cell is the only stained portion. More often the cell may consist of two stained and three unstained cross-bands. The staining of this type differs from that of Type II., in that the alternating segments of Type II. are narrow and numerous and the terminal ones are always stained.

Modifications of these types and intermediate forms occur even among bacilli of the same culture, but in nearly every case one form predominates sufficiently to allow the culture to be ranged under one of these three types. In the routine work of bacteriological diagnosis of diphtheria, as carried on under the direction of the State Board of Health, Type I. and its modifications are found in about 90 per cent. of the positive cases and bacilli of Type II. make up the greater part of the other 10 per cent. Bacilli of Type III. are very infrequently found. This classification holds good for young cultures on Löffler's serum mixture only.

Bacilli belonging to these three types have so far proved virulent to guinea-pigs when tested according to the methods given in another part of the text. But besides these a certain number of bacilli (Nos. 3, 4, 39 and 44 of the tables) have been isolated which are non-pathogenic, and which belong to the class of pseudo-diphtheria bacilli described farther on.

TOXIN-PRODUCING POWER.

The toxicity of the culture fluid of the forty-six cultures after an incubation at 35° C. for ten to twelve days ranged as follows, the 300-gramme guinea-pig being the basis of the computations: —

	Cubic Centimeters.
In one the minimum fatal dose is	.036–.04
In one the minimum fatal dose is	.045
In five the minimum fatal dose is	.050
In five the minimum fatal dose is	.060
In four the minimum fatal dose is	.070
In four the minimum fatal dose is	.075
In eleven the minimum fatal dose is	.080
In two the minimum fatal dose is	.090
In four the minimum fatal dose is	.100
In five the minium fatal dose is	.120
In four no toxin was formed.	

Leaving aside for the moment the non-pathogenic forms, we notice in this summary, first of all, a considerable uniformity in the toxin-producing power. It is true the strongest toxin producer accumulates three times as much toxin as the weakest, but only one of such strength was found. It will be noticed also that the greater number of bacilli studied produce an 0.08 cubic centimeter toxin. If we group the cultures as follows, —

	Cultures.
.036-.06 cubic centimeter toxins,	12
.070-.09 cubic centimeter toxins,	21
.100-.12 cubic centimeter toxins,	9

the predominance of the middle group is better brought out.

Cultures of much greater toxin-producing power have been isolated by Park and Williams. Of these, the minimum fatal dose is reported to range from 0.002 to 0.01 cubic centimeter. It is not stated whether these cultures produced this amount of toxin at the outset, or after periods of artificial cultivation.

By comparing these figures with the results of earlier observers, the greater efficiency of the method described appears in striking relief. Experimenters when first preparing antitoxin had some difficulty in finding bacilli whose toxin would yield a minimum fatal dose of 0.08 to 0.1 cubic centimeter. In the series here recorded only five out of forty-two fell below this mark.

Although the clinical records of the cases from which the bacilli came are very meagre, they suffice to show that any direct relation

between toxin production and severity of the disease is not obvious. This has been the inference of observers before us (Wright, Park and very recently Timaschew *), and we are able to confirm it after the application of more uniform and exact methods. This is what might be expected when we contemplate the complex nature of the disease process, the many factors which may enter into it, both on the part of the patient and the invading bacilli. There is one factor, for instance, which may modify the course of the disease, and therefore make any present-day estimates untrustworthy, — namely, antitoxin. If applied early enough, it may convert a potentially serious case into a mild one, in spite of a virulent organism. Antitoxin was used in nearly every case from which bacilli were studied, but the time of administration and the number of units injected were not reported excepting in a few cases, so that the facts on hand are not worth any serious study. All that can be said is that the toxin-producing power of bacilli from mild and from severe cases varies but little, and that all throat affections must be regarded equally dangerous if diphtheria bacilli are present.

The Toxin-producing Power of Bacilli persisting in the Throat after Recovery.

Much interest has been aroused by the patients in whose throats diphtheria bacilli may be found a variable length of time after subsidence of all symptoms of disease. Löffler, in his investigation of the ætiology, found diphtheria bacilli in the throat of a healthy child. Roux and Yersin first called attention to the persistence of diphtheria bacilli after recovery, but they disseminated the impression that there was a gradual attenuation going on which eventually made them harmless. That this may be true in certain cases is not disputed, otherwise it would be difficult to account for the presence, in the mouth of some healthy persons, of bacilli in no way distinguishable from those associated with disease processes except by an absence of virulence.† This attenuation has not been observed by subsequent investigators, however, and no reliance can be placed upon it to purge the throat of the recovered case of its infectious character.

Among the forty-six cultures studied there were eleven made from the throat fifteen to sixty-two days after the appearance of the dis-

* "Centralblatt f. Bakteriologie," XXI. (1897), page 623.

† Park and Beebe, *loc. cit.*, page 37.

ease. Owing to the meagre records returned, it is impossible to state how long *after* the subsidence of the symptoms the bacilli were obtained from the throat; but by a reference to Table II., where the relative severity of each case is noted, some idea may be gained by the reader of the probable duration. The following table summarizes these cases. It includes two from which harmless pseudo-forms were obtained: —

Number of Culture.	Date of Earliest Symptoms.	Date of Culture.	Interval (in Days).	Minimum Fatal Dose of Toxin (Cubic Centimeters).
23, ...	July 12, 1896.	Aug. 3, 1896.	22	.07
24, ...	July 14, 1896.	Sept. 9, 1896.	57	.08
26, ...	Aug. 28, 1896.	Oct. 19, 1896.	52	.05
27, ...	Sept. 27, 1896.	Oct. 19, 1896.	22	.06
34, ...	Oct. 22, 1896.	Nov. 17, 1896.	26	.05
36, ...	Nov. 15, 1896.	Nov. 30, 1896.	15	.08
39, ...	Nov. 22, 1896.	Dec. 29, 1896.	37	Not toxic.
40, ...	Dec. 18, 1896.	Jan. 4, 1897.	17	.12
42, ...	Dec. 31, 1896.	Jan. 16, 1897.	16	07
43, ...	Feb. 20, 1897.	March 19, 1897.	27	.08
44, ...	Feb. 8, 1897.	March 25, 1897.	45	Not toxic.
45, ...	Feb. 9, 1897.	March 23, 1897.	42	.08
46, ...	Jan. 29, 1897.	April 1, 1897.	62	.08

If we exclude the harmless, non-toxic cultures (Nos. 39, 44), which will be discussed farther on, we observe that, so far as toxin production is concerned, the length of time the bacilli have sojourned in the throat has no tendency to reduce it below the average. This is still better brought out by arranging the cultures in the following groups: —

Group.	Days after Beginning of Disease.	Number of the Culture.	Toxicity (Cubic Centimeters).
		35	.08
I., ...	15 to 20	40	.12
		42	.07
		23	.07
II., ...	20 to 30	27	.06
		34	.05
		43	.08
		24	.08
III,.	50 to 62	26	.05
		45	.08
		46	.08

Still more to the point are cultures Nos. 22 and 23, which were isolated from the same case, one three, the other twenty-two, days after the onset of the disease. Here the toxin production was practically the same for both cultures.

Pseudo-Diphtheria Bacilli.

From the table it will be seen that four of the forty-six cultures isolated were found to be pseudo-diphtheria bacilli. It does not lie within the scope of this paper to discuss at length the relation between the true diphtheria bacillus and the pseudo-diphtheria bacillus. A very good discussion will be found in the work of Park and Beebe, to which the reader is referred. Since its appearance nothing new has been added to this subject. These bacilli, however, influence to a certain degree the interpretation of problems in public sanitation, so that a brief reference to them becomes necessary.

These bacilli, generally known as pseudo-diphtheria bacilli, are short rods (1.5 μ to 3 μ), with rounded or tapering ends (often oval in culture), and uniformly stained, or with a single narrow, unstained cross-segment. A few cylindrical, pear and hour-glass shaped bacilli are occasionally seen; but involution forms are not marked, even in old cultures. They are distinguished from diphtheria bacilli by being shorter, smaller, more uniform in size, shape and manner of staining, and, as pointed out by Escherich, by a tendency to lie parallel in cover-slip preparations. These bacilli are of occasional occurrence, both in the throats of patients suffering from non-diphtheritic throat affections and in true diphtheria mingled with the Klebs-Löffler bacilli. They are, however, almost always present in small numbers, while the diphtheria bacilli, in recent cases, are usually present in large numbers and well differentiated. It is only in convalescent cases of long duration that the pseudo-diphtheria bacilli are likely to cause doubt. They might be mistaken for the last few remaining diphtheria bacilli, or the reverse might occur. A few remaining virulent forms may be regarded as pseudo-forms. Diphtheria bacilli directly from the membrane from the throat, or from cultures scarcely at all developed, sometimes resemble quite closely the pseudo-diphtheria bacilli in morphology and staining.

The morphological differences are reinforced by at least two biological differences of importance, — the absence of any power to produce acids in bouillon containing dextrose, and the lack of

pathogenic power. In Table I. it will be seen that all toxin-producing bacilli, when multiplying in bouillon containing 1 per cent. dextrose, produce a considerable amount of acid, ranging from 3.5 to 5 per cent. of a normal acid solution when phenolphthallein is used as an indicator. A few cultures were found which produce between 5 and 6 per cent. The pseudo-diphtheria bacilli produced no acid under the same circumstances. The culture slowly becomes more alkaline, as shown in the table (Nos. 3, 4, 39, 44). The culture fluid of these bacilli was likewise free from toxin. Guinea-pigs which received from six to twelve times the average fatal dose of the virulent cultures showed no trace of infiltration at the place of injection and no loss in weight.

Though there are these three distinctive features of pseudo-diphtheria bacilli, — characteristic morphology, absence of acid and of toxin production, — it is not a simple matter to recognize them as such promptly under the microscope when taken from throat cultures, unless the observer has had considerable training. It is highly probable, therefore, that Roux and Yersin in their earlier work may have mistaken pseudo-diphtheria bacilli for true diphtheria bacilli, when they found virulent and non-virulent forms together in the throats of convalescents. This may explain their at that time quite natural position, — that the virulent forms were being transformed into non-virulent forms. In two of the cases tabulated above (Nos. 39 and 44) the pseudo-diphtheria bacilli were isolated respectively thirty-seven and forty-five days after the beginning of the disease. Here, without a more profound study of the cultures, the belief might gain the upper hand that the cultures represented diphtheria bacilli which had lost their virulence. This position can no longer be upheld, and we must accept or at least act upon the presumption that the pseudo-diphtheria bacilli belong to a wholly different group of bacilli, and that a loss of pathogenic power of the genuine forms does not take place in the mouth for months after the subsidence of the disease, when such forms persist after recovery.

Of the non-virulent but otherwise characteristic diphtheria bacilli, described by Park and Beebe and by others more recently, none have come under observation.

Table I.

Designation of Bacillus.	Acid Production in 1 Per Cent. Dextrose Bouillon. (see p. 665.)	Toxin Production in Bouillon. Designation of Bouillon	Quantity of Muscle Sugar (Per Cent.)	Mode of Cultivation.	Original Reaction (See p. 655.)	Final Reaction.	Toxin Tested on Guinea-pigs. Weight of Animal (Grms.)	Dose of Toxin, Subcutaneous (Cubic Centimeters).	Date of Test.	Result of Test.	Minimum Fatal Dose (calculated in Cubic Centimeters).
1, . . .	5.35; 3.89	90	Trace	Inclined test tube,	—1.00	+.10	396	.10	May 29, 1896,	Dies in 5 days, . . .	.080
		90	Trace.	Inclined test tube,	—1.00	—.15	345	.10	June 11, 1896,	Slough, ...	.120
		90	Trace.	Inclined test tube,	—1.00	+.30	302	.10	July 6, 1896,	Dies in 16 days, . .	.100
		112	Trace.	Inclined test tube,	—1.10	+.00	315	.10	July 6, 1896,	Dies in 2½ days, . .	.060
		193	.02-.04	Flask, . . .	—.90	+.10	300	.10	Feb. 25, 1897,	Dies in 1½ days, . .	.060
2, . . .	5.39	90	Trace.	Inclined test tube,	—1.00	+.10	390	.05	May 29, 1896,	Slough, ...	-
		193	.02-.04	Flask, . . .	—1.10	+.20	300	.10	Feb. 25, 1897,	Dies in 1½ days, . .	.060
3, . . .	No acid.	90	Trace.	Inclined test tube,	—1.00	+.10	350	.50	May 29, 1897,	No effect; non-pathogenic,	-
4, . . .	No acid.	90	Trace.	Inclined test tube,	—1.00	+.10	370	.50	May 29, 1897,	No effect; non-pathogenic,	-
5, . . .	3.76; 4.41	90	Trace.	Inclined test tube,	—1.00	—.[illegible]	396	.10	June 11, 1896,	Dies in 8½ days, . .	.080
6, . . .	4.14	90	Trace.	Inclined test tube,	—1.00	—.15	350	.10	June 11, 1896,	Dies in 2½ days, . .	.075
		115	Trace.	Inclined test tube,	—1.10	+.00	293	.10	Aug. 12, 1896,	Dies in 2 days, . .	.075
7, . . .	4.68	90	Trace.	Inclined test tube,	—1.00	—.35	330	.10	June 11, 1896,	Dies in 4½ days, . .	.080
8, . . .	3.86; 4.19	90	Trace.	Inclined test tube,	—1.00	—.28	300	.10	June 29, 1896,	Slough, ...	.120
9, . . .	4.87	90	Trace.	Inclined test tube,	—1.00	—.22	285	.06	June 29, 1896,	Slough, ...	.120
10, . . .	4.90	90	Trace.	Inclined test tube,	—1.90	—.38	325	.10	June 29, 1896,	Dies in 5 days, . .	.100

11, . .	4.25	90	Trace.	Inclined test tube,	—1.00	—.46	315	.10	June 29, 1896,	Slough, ...	.120
12, . .	3.85	90	Trace.	Inclined test tube,	—1.00	—.21	310	.10	June 29, 1896,	Dies in 2 days, . . .	.075
	3.93	115	Trace.	Inclined test tube,	—1.10	+.00	455	.10	Aug. 12, 1896,	Dies in 3½ days, . .	.070
	4.89	140	.05	Flask, . . .	—1.40	+.00	515	.10	Nov. 19, 1896,	Dies in 1½ days, . .	.040
		176	None.	Flask, . . .	—1.10	+.20	335	.05	Jan. 28, 1897,	Dies in 2½ days, . .	.045
13, . .	4.17	112	Trace.	Inclined test tube,	—1.10	+.10	304	.10	July 22, 1896,	Dies in 2⅙ days, . .	.080
14, . .	3.91 .	112	Trace.	Inclined test tube,	—1.10	—.10	308	.10	July 22, 1896,	Dies in 1½ days, . .	.040
	3.94	115	Trace.	Inclined test tube,	—1.10	—.05	312	.10	Aug. 12, 1896,	Dies in 1½ days, . .	.040
		140	.05	Flask, . . .	—1.40	—.68	502	.10	Nov. 19, 1896,	Dies in 1⅝ days, . .	.040
		176	None.	Flask, . . .	—1.10	+.00	315	.05	Jan. 28, 1897,	Dies in 1¾ days, . .	.040*
		176	None.	Flask, . . .	—1.10	+.00	360	.05	Feb. 4, 1897,	Dies in 2½ days, . .	.040
		176	None.	Flask, . . .	—1.10	+.00	360	.10	Feb. 4, 1897,	Dies in 1¼ days, . .	.040
		297	Trace.	Flask, . . .	—1.55	+.00	316	.04	Mar. 30, 1897,	Dies in 2¼ days, . .	.036
15, . .	3.96	115	Trace.	Inclined test tube,	—1.10	—.10	309	.10	Aug. 12, 1896,	Dies in 3¼ days, . .	.090
16, . .	4.16	112	Trace.	Inclined test tube,	—1.10	—.13	309	.10	July 22, 1896,	Dies in 2 days, . .	.075
17, . .	4.31	112	Trace.	Inclined test tube,	—1.10	—.20	308	.10	July 22, 1896,	Dies in 2 days, . .	.075
18, . .	3.78	115	Trace.	Inclined test tube,	—1.10	+.00	313	.10	Aug. 12, 1896,	Dies in 6 days, . .	.100
19, . .	4.07	115	Trace.	Inclined test tube,	—1.10	+.00	310	.10	Aug. 12, 1896,	Slough, ...	.120
20, . .	Lost.	115	Trace.	Inclined test tube,	—1.10	+.00	313	.10	Aug. 12, 1896,	Dies in 1⅝ days, . .	—*
		120	Trace.	Inclined test tube,	—.70	+.00	370	.10	Oct. 9, 1896,	Dies in 2½ days, . .	.080
21, . .	4.28	115	Trace.	Inclined test tube,	—1.10	—.15	308	.10	Aug 12, 1896,	Dies in 4½ days, . .	.100

* Injection intra-abdominal, by accident.

TABLE I. — *Concluded.*

Designation of Bacillus.	Acid Production in 1 Per Cent. Dextrose Bouillon. (See p. 665.)	Toxin Production in Bouillon.					Toxin Tested on Guinea-pigs.				Minimum Fatal Dose (calculated in Cubic Centimeters).
		Designation of Bouillon	Quantity of Muscle Sugar (Per Cent.).	Mode of Cultivation.	Original Reaction. (See p. 665.)	Final Reaction.	Weight of Animal (Grms.).	Dose of Toxin, Subcutaneous (Cubic Centimeters).	Date of Test.	Result of Test.	
22, . . .	4.19	115	Trace.	Inclined test tube,	—1.10	—.05	315	.10	Aug. 12, 1896,	Dies in $1\frac{5}{8}$ days, . .	.070
		176	None.	Flask, . . .	—1.10	+.20	300	.10	Feb. 17, 1897,	Dies in $2\frac{1}{8}$ days, . .	.080
23, . . .	4.46	129	Trace.	Inclined test tube,	—.70	—.20	374	.10	Oct. 9, 1896,	Local swelling, . .	-
		140	.05	Flask, . . .	—1.40	—.64	520	.10	Nov. 19, 1896,	Dies in 3 days, . . .	.070
		176	None.	Flask, . . .	—1.10	+.20	300	.10	Feb. 17, 1897,	Dies in 2 days, . . .	.075
24, . . .	4.83	129	Trace.	Inclined test tube,	—.70	+.00	372	.10	Oct. 9, 1896,	Dies in $2\frac{1}{2}$ days, . .	.080
25, . . .	4.75	140	.05	Flask, . . .	—1.40	—1.15	580	.10	Nov. 19, 1896,	Dies in 3 days, . . .	.050
		193	.02-.04	Flask, . . .	—.90	—.05	300	.10	Feb. 25, 1897,	Dies in $1\frac{1}{2}$ days, . .	.050
26, . . .	4.86	140	.05	Flask, . . .	—1.40	—.27	540	.10	Nov. 19, 1896,	Dies in 2 days, . . .	.050
27, . . .	4.65	140	.05	Flask, . . .	—1.40	—.38	530	.10	Nov. 19, 1896,	Dies in $2\frac{1}{2}$ days, . .	.060
28, . . .	5.88 6.81	140	.05	Flask, . . .	—1.40	—.54	500	.10	Nov. 19, 1896,	Dies in $2\frac{1}{2}$ days, . .	.060
29, . . .	4.72	159	.05-.08	Flask, . . .	—1.20	—.74	520	.13	Dec. 26, 1896,	Slough, ...	.100
30, . . .	4.82	159	.05-.08	Flask, . . .	—1.20	—.38	615	.13	Dec. 26, 1896,	Dies in 10 days, . .	.070
31, . . .	4.74	159	.05-.08	Flask, . . .	—1.20	—1.35	630	.13	Dec. 26, 1896,	Slough, ...	-
		176	None.	Flask, . . .	—1.10	+.10	300	.10	Feb. 13, 1897,	Dies in $1\frac{5}{8}$ days, . .	.070
32, . . .	(?)	151	Trace.	Flask, . . .	(?)	—.08	430	.10	Dec. 10, 1896,	Dies in $2\frac{1}{8}$ days, . .	.070

33, . .	4.42	159	.05-.08	Flask, . . .	—1.20	—1.25	590	.13	Dec. 26, 1896,	Slough, ...	.080 (?)
		193	.02-.03	Flask, . . .	—.90	+.10	300	.10	Feb. 25, 1897,	Dies in 1½ days, . .	.050
34, . .	4.78	159	.05-.08	Flask, . . .	—1.20	—1.00	540	.13	Dec. 26, 1896,	Dies in 2 days, . . .	.050
		176	None.	Flask, . . .	—1.10	+.20	330	.05	Feb. 17, 1897,	Dies in 11¼ days, . .	0.50
35, . .	4.87	159	.05-.08	Flask, . . .	—1.20	—2.33	660	.13	Dec. 26, 1896,	Slough, ...	-
		176	None.	Flask, . . .	—1.10	+.00	325	.10	Feb. 17, 1897,	Dies in 2¾ days, . .	.090
36, . .	4.37	176	None.	Flask, . . .	—1.10	+.10	410	.10	Jan. 26, 1897,	Dies in 4½ days, . .	.080
37, . .	4.00	176	None.	Flask, . . .	—1.10	+.10	380	.10	Jan. 26, 1897,	Dies in 1¾ days, . .	.060
38, . .	4.23	176	None.	Flask, . . .	—1.10	+.30	360	.10	Jan. 26, 1897,	Dies in 1¾ days, . .	.060
39, . .	.32	176	None.	Flask, . . .	—1.10	+.00	550	1.00	Jan. 26, 1897,	No effect, ...	-
40, . .	4.79	176	None.	Flask, . . .	—1.10	+.20	370	.10	Jan. 26, 1897,	Slough, ...	-
		176	None.	Flask, . . .	—1.10	+.20	350	.15	Feb. 4, 1897,	Dies in 2½ days, . .	.120
41, . .	4.28	176	None.	Flask, . . .	—1.10	+.20	410	.10	Jan. 26, 1897,	Dies in 6¼ days, . .	.080
42, . .	4.14	176	None.	Flask, . . .	—1.10	(?)	470	.10	Jan. 26, 1897,	Dies in 2½ days, . .	.070
43, . .	5.20	226	Faint trace.	Flask, . . .	—1.30	—.15	384	.10	Apr 27, 1897,	Dies in 2½ days, . .	.080
44, . .	.55	226	Faint trace.	Flask, . . .	—1.30	—.55	404	1.00	Apr. 27, 1897,	No effect, ...	-
45, . .	4.83	226	Faint trace.	Flask, . . .	—1.30	—.00	312	.10	Apr. 27, 1897,	Dies in 2¼ days, . .	.080
46, . .	4.67	226	Faint trace.	Flask, . . .	—1.30	—.75	307	.16	Apr. 27, 1897,	Dies in 1½ days, . .	.060

TABLE II.

Designation of Culture.	Locality.	Age of Patient (Years).	Date of Earliest Symptoms.	Date of Culture.	Nature of Case.	Antitoxin Used.	Termination of Case.	Minimum Fatal Dose of Toxin on Guinea-pigs (Cubic Centimeters).	Remarks.
1	Everett, .	1½	April 19, '96,	April 21, '96,	Severe, membranous croup.	No,	Death, .	.080	Bacilli of medium length, cylindrical or slightly swollen in the middle, and with deeply stained granules.
2	Everett, .	3	April 27, '96,	April 27, '96,	Mild, with laryngeal symptoms.	Yes,	Recovery,	.050	Bacilli of medium length, rather thick, cylindrical or slightly swollen in the middle, and with deeply stained granules.
3	Fitchburg, .	23	May 8, '96,	May 11, '96,	Scarlet-fever, . .	No,	Recovery,	No effect.	Bacilli short (about 2 μ), with rounded or tapering ends, and with a single unstained or faintly stained cross-segment.
4	Everett, .	2½	May 10, '96,	May 12, '96,	Moderately severe, .	Yes,	Death, .	No effect.	Bacilli short (from 1.5 μ to 2 μ), oval, evenly stained, or with a single very narrow unstained cross segment.
5	S. Braintree, .	5	May 11, '96,	May 16, '96,	Severe, with laryngeal symptoms.	Yes,	Death, .	.080	Bacilli of various lengths, with tapering ends or variously swollen, and with large unstained terminal and intermediate segments.
6	E. Saugus, .	7	May 20, '96,	May 22, '96,	Well-marked case, with laryngeal symptoms	Yes,	Recovery,	.075	Bacilli rather below medium length, considerably swollen in the middle, many being with tapering ends, and with large unstained terminal and intermediate segments.
7	Everett, .	8	May 19, '96,	May 20, '96,	Severe, ...	Yes,	Recovery,	.060	Bacilli of medium length, with tapering ends, and with unstained terminal and intermediate segments; a few cylindrical forms with deeply stained granules
8	E. Somerville,	7	May 25, '96,	May 25, '96,	Mild, ...	Yes,	Recovery,	.120	Bacilli rather long, slender, cylindrical or with slightly swollen ends, and with deeply stained polar granules.
9	Somerville, .	8	May 24, '96,	May 26, '96,	Mild, ...	No,	Recovery,	.120	Bacilli of medium length, or long bacilli, that are cylindrical or with slightly swollen ends and with alternating stained and unstained cross-segments.
10	Watertown, .	19	May 28, '96,	May 28, '96,	Severe, with laryngeal symptoms.	(?)	Recovery,	.100	Bacilli of medium length, with tapering ends, and with a stained nucleus like body in an otherwise colorless cell.
11	Roslindale, .	20	May 30, '96,	June 4, '96,	Severe, with laryngeal symptoms.	Yes,	Recovery,	.120	Bacilli of medium length, straight, cylindrical or slightly swollen in the middle, and with deeply stained polar granules
12	E. Somerville,	7	June 4, '96,	June 6, '96,	Severe, ...	Yes,	Recovery,	.040	Bacilli of medium length, or long bacilli, that are cylindrical or with slightly swollen ends, and with alternating stained and unstained cross-segments
13	Somerville, .	18	June 9, '96,	June 10, '96,	Mild, ...	Yes,	Recovery,	.080	Bacilli rather short, plump, with tapering ends, and with unstained terminal and intermediate segments.
14	Hyde Park, .	9½	June 15, '96,	June 16, '96,	Severe, ...	Yes,	Recovery,	.036	Bacilli rather long, slender, curved, cylindrical or with slightly swollen ends, and with alternating stained and faintly stained cross segments.
15	Everett, .	2½	June 15, '96,	June 16, '96,	Severe, with laryngeal symptoms.	Yes,	Recovery,	.090	Bacilli of medium length, cylindrical or slightly swollen in the middle, and mostly evenly stained.

16	Somerville,	3½	June 16, '96,	June 17, '96,	Rather severe,	Yes,	Recovery,	.075	Bacilli of medium length, slightly swollen in the middle, and with faintly stained ends and intermediate segments.
17	Everett,	17	June 23, '96,	June 24, '96,	Severe,	Yes,	Recovery,	.075	Bacilli of various lengths, slender, with tapering ends or with swollen ends, and with broad unstained cross-segments
18	Winchester,	17	July 2, '96,	July 4, '96,	Mild,	Yes,	Recovery,	.100	Bacilli of medium length, or long bacilli, that are slender, cylindrical or slightly swollen in the middle or irregularly swollen, and with unstained ends and one or more intermediate segments
19	Somerville,	16	July 2, '96,	July 6, '96,	Mild,	Yes,	Recovery,	.120	Bacilli rather below medium length, cylindrical or slightly swollen in the middle, and with deeply stained granules.
20	Salem,	7	July 2, '96,	July 6, '96,	Severe,	Yes,	Recovery,	.080	Bacilli short, small, mostly swollen in the middle, with tapering ends, and with faintly stained terminal and intermediate segments.
21	Everett,	13	July 6, '96,	July 6, '96,	Mild,	Yes,	Recovery,	.100	Bacilli of medium length, or long bacilli, that are slender, cylindrical or with swollen ends, and with alternating stained and unstained cross segments
22	S. Hanover,	11	July 12, '96,	July 15, '96,	Well-defined case,	Yes,	Recovery,	.070	Bacilli long, curved, with more or less swollen ends, and with alternating deeply stained and faintly stained cross-segments
23	S Hanover,	11	July 12, '96,	Aug. 3, '96,	From same patient as No. 22.	–	–	.070	Bacilli rather long, slender, curved, with pronounced swelling at the ends, and with alternating deeply stained and faintly stained cross-segments.
24	Somerville,	3	July 14, '96,	Sept. 9, '96,	Very mild,	Yes,	Recovery,	.080	Bacilli of medium length, straight, cylindrical, and with deeply stained granules.
25	Somerville,	6	Oct. 11, '96,	Oct. 13, '96,	Severe, with laryngeal symptoms.	Yes,	Recovery,	.050	Bacilli of medium length, or rather long bacilli, that are straight, cylindrical, and with deeply stained polar granules
26	Norwell,	5	Aug. 25, '96,	Oct. 19, '96,	Severe,	Yes,	Recovery,	.050	Bacilli of medium length, straight, cylindrical or slightly swollen in the middle, and with deeply stained granules.
27	Salem,	10	Sept. 27, '96,	Oct. 19, '96,	Very severe,	Yes,	Recovery,	.060	Bacilli of medium length, cylindrical or with somewhat pointed ends, and with deeply stained granules
28	Danvers,	7	Oct. 20, '96,	Oct. 23, '96,	Mild,	Yes,	Recovery,	.080	Bacilli long, slender, curved, cylindrical or more or less swollen at the ends, and with alternating stained and unstained cross segments.
29	W. Everett,	11	Oct. 14, '96,	Oct. 24, '96,	Mild,	Yes,	Recovery,	.100	Bacilli of medium length, straight, mostly cylindrical, and with deeply stained granules.
30	Watertown,	8	Oct. 26, '96,	Oct. 27, '96,	Condition not given,	Yes,	Recovery,	.070	Bacilli long, cylindrical, or slightly swollen at the ends, and with thickly alternating stained and unstained cross-segments
31	Salem,	3	Oct. 30, '96,	Oct. 31, '96,	–	–	–	.070	Bacilli rather short (1.9 μ), straight, slender, cylindrical or slightly swollen in the middle, and with deeply stained granules
32	W. Medford,	12	Nov. 7, '96,	Nov. 7, '96,	Mild,	Yes,	Recovery,	.070	Bacilli of medium length, or short bacilli, that are straight, slender, cylindrical, and with deeply stained granules.
33	Medford,	2	Nov. 16, '96,	Nov. 17, '96,	Severe, with laryngeal symptoms.	Yes,	Recovery,	.050	Bacilli very long, very slender, with slightly swollen ends, and with alternating stained and unstained cross-segments.
34	Taunton,	6	Oct. 22, '96,	Nov. 17, '96,	Mild,	Yes,	Recovery,	.050	Bacilli of medium length, very slender, cylindrical, and with deeply stained granules.

TABLE II. — *Concluded.*

Designation of Culture.	Locality.	Age of Patient (Years).	Date of Earliest Symptoms.	Date of Culture.	Nature of Case.	Antitoxin Used.	Termination of Case.	Minimum Fatal Dose of Toxin on Guinea-pigs (Cubic Centimeters).	Remarks.
35	Watertown, .	17	Nov. 26, '96,	Nov. 27, '96,	Moderately severe, .	Yes,	Recovery,	.090	Bacilli of medium length, very slender, straight, cylindrical, and with deeply stained granules.
36	Beverly, .	2	Nov. 15, '96,	Nov. 30, '96,	Severe, with laryngeal symptoms.	Yes,	Recovery,	.080	Bacilli of medium length, mostly straight, cylindrical or slightly swollen in the middle, and with deeply stained polar granules.
37	Beverly, .	19	Nov. 16, '96,	Nov. 21, '96,	Severe, ...	Yes,	Recovery,	.060	Bacilli of medium length, or short bacilli (1.5 μ to 3 μ), that are mostly straight, cylindrical or slightly swollen in the middle, and with deeply stained granules.
38	No. Adams, .	1	Dec. 23, '96,	Dec. 24, '96,	Severe, with laryngeal symptoms.	Yes,	Recovery,	.060	Bacilli of medium length, cylindrical or slightly swollen at the ends, and with alternating stained and unstained cross-segments.
39	Watertown, .	6	Nov. 22, '96,	Dec. 29, '96,	Severe, ...	Yes,	Recovery,	No effect.	Bacilli rather short, with rounded or tapering ends, and with a single unstained cross segment.
40	Beverly, .	10	Dec. 18, '96,	Jan. 4, '97,	Severe, with laryngeal symptoms.	Yes,	Recovery,	.120	Bacilli rather long, slender, curved, more or less swollen at the ends, and with alternating deeply stained and faintly stained cross segments.
41	Chelsea,	8	Dec. 31, '96,	Jan. 6, '97,	Laryngeal symptoms, .	Yes,	Recovery,	.080	Bacilli long, slender, curved, more or less swollen at the ends, and with alternating stained and unstained cross-segments.
42	Lexington, .	16	Dec. 31, '96,	Jan. 16, '97,	Mild, ...	Yes,	Recovery,	.070	Bacilli of medium length, straight, slender, cylindrical, and with deeply stained granules
43	Hingham, .	53	Feb. 20, '97,	Mar. 19, '97,	Mild, ...	Yes,	Recovery,	.080	Bacilli of medium length, or long bacilli, that are mostly cylindrical, and with deeply stained granules.
44	Beverly, .	18	Feb. 8, '97,	Mar. 25, '97,	Mild, ...	Yes,	Recovery,	No effect.	Bacilli short, regular, and evenly stained or with a single unstained cross-segment.
45	Danvers, .	18	Feb. 9, '97,	Mar. 23, '97,	Mild, ...	Yes,	Recovery,	.080	Bacilli long, rather thick, cylindrical or slightly swollen at the ends, and with alternating deeply stained and faintly stained cross-segments.
46	Danvers, .	26	Jan. 29, '97,	April 1, '97,	Severe, ...	Yes,	Recovery,	.080	Bacilli rather long and large, mostly slightly swollen in the middle, and with deeply stained granules.

REPORT

UPON THE

PRODUCTION AND USE OF ANTITOXIN.

REPORT

UPON THE

PRODUCTION AND USE OF ANTITOXIN,

FOR THE

TWELVE MONTHS ENDING MARCH 31, 1897.

This second report upon this subject is intended to present the practical details of the work of the Board in this direction for the space of one year, following immediately after the termination of the first summary presented in the last annual report. The unavoidable delay in publishing the annual reports, which contain accounts of the general work of the Board for the different years of official work, permits the extension of the time of this portion up to the first of April. Another reason for this method of presentation exists in the fact that the Board began the first distribution of its antitoxin at that season of the year (about April 1, 1895).

The general supervision of the production of antitoxin for the Board throughout the year has been in charge of Dr. Theobald Smith, assisted by J. R. Stewart, and the work has been performed at the bacteriological laboratory of the Board, at the Bussey Institute. The minor details of the work (labelling, packing, mailing, recording and correspondence) have been performed at the office of the Board, at the State House.

The strength of the serum issued during the year embraced in this report was maintained substantially at a uniform standard of 100 units per cubic centimeter.

A considerable quantity of a weaker serum, having a strength of 60 to 80 units per cubic centimeter, has also been prepared and furnished for use to such authorities as have desired it for the purpose of immunization only.

During the early part of 1895 the Board had issued antitoxin to the Boston City Hospital for use in its contagious disease depart-

ment, but this demand ceased as soon as the city board of health began issuing antitoxin.

That the use of antitoxin is steadily increasing and that this therapeutic agent is growing in favor among physicians is shown by the fact that the number of packages issued by the Board has nearly doubled, when the figures of 1896 are compared with those of 1895. Nor is this due to an increase in the prevalence of diphtheria during these two years, since the returns of deaths received at the time of writing this report indicate a lessened mortality from this cause.

It is to be regretted that the returns of cases treated by physicians are very much smaller in number than the actual number of cases treated, the ratio of returns to cases treated being even less than that of 1895, if the number of bottles issued is an indication of the number used. The statements as to the probable cause of this deficiency, which were published in the last annual report, are quite as applicable to the conditions prevailing in 1896.

The total amount of diphtheria antitoxin issued by the Board during the year ended March 31, 1897, was 3,245 bottles, containing in all about 35,000 cubic centimeters of serum, nearly all of which was of a uniform strength of 100 units per cubic centimeter. This serum was distributed to local boards of health and to physicians in the following cities and towns: —

Showing Number of Bottles of Diphtheria Antitoxin distributed from April 1, 1896, to March 31, 1897.

City or Town.	Number Bottles.	City or Town.	Number Bottles.
Boston:		Hyde Park,	69
Children's Hospital,	263	Beverly,	67
General supply,	89	Springfield,	66
Cambridge,	270	Weymouth,	62
Lynn,	196	Danvers,	61
Worcester,	159	Taunton,	59
Newton,	132	Medford,	48
Waltham,	126	Amesbury,	47
Everett,	113	Brookline,	45
Pittsfield,	102	Chelsea,	45
Somerville,	98	Lowell,	45
Fitchburg,	95	Haverhill,	45
Woburn,	85	Salem,	45

Showing Number of Bottles of Diphtheria Antitoxin distributed from April 1, 1896, to March 31, 1897 — Concluded.

City or Town.	Number Bottles.	City or Town.	Number Bottles.
North Adams,	42	Milton,	10
Malden,	41	Natick,	9
Watertown,	38	Southbridge,	9
Ware,	36	Attleborough,	7
Milford,	34	Acton,	7
Adams,	31	Ayer,	7
Quincy,	31	Concord,	7
Marlborough,	28	Edgartown,	7
Brockton,	26	Norwell,	6
Holbrook,	25	Rockport,	6
Tewksbury,	24	Groton,	6
Winchester,	23	Braintree,	5
Randolph,	19	Northampton,	5
Peabody,	17	West Brookfield,	5
New Bedford,	17	Whitman,	5
Bedford,	16	Westborough,	5
Winchendon,	16	Rockland,	5
Lawrence,	16	Winthrop,	5
Marblehead,	16	East Bridgewater,	4
Dedham,	15	Monson,	4
Stoneham,	14	Shirley,	3
Holyoke,	14	Rockland,	3
Wakefield,	14	Westford,	2
Clinton,	14	Revere,	2
Hanover,	13	Hinsdale,	2
Norwood,	12	Andover,	2
Hingham,	12	Cottage City,	2
Warren,	12	Middleborough,	2
Westfield,	11	Georgetown,	2
Winthrop,	11	Harvard,	2
Lexington,	11	Abington,	2
Arlington,	11	Westminster,	2
Framingham,	11	Foxborough,	2
Leominster,	11	Total,	3,219
North Attleborough,	10		

The following list presents the names of the cities and towns from which detailed reports were received relative to the use of antitoxin, with the number from each town and the number of physicians reporting in each during the year ended March 31, 1897 : —

List of Cities and Towns from which Reports have been received relative to the Use of Antitoxin in the Treatment of Diphtheria, with the Number of Reports from Each and the Number of Physicians reporting in Each.

PLACES.	Number Physicians reporting.	Cases in which Cultures were made.	Cultures were not made.	PLACES.	Number Physicians reporting.	Cases in which Cultures were made.	Cultures were not made.
Lynn,	6	12	42	Ware,	1	–	3
Woburn,	8	3	24	Ayer,	2	2	–
Worcester,	14	30	–	Quincy,	2	–	4
Waltham,	6	22	11	Milton,	1	3	2
Medford,	7	10	22	Lexington,	1	2	1
Chelsea,	2	16	1	Newton,	3	2	–
Everett,	4	9	3	Framingham,	1	–	3
Tewksbury,	3	9	–	Randolph,	1	–	3
Cambridge,	5	9	4	Wakefield,	2	2	1
Haverhill,	9	5	13	Westborough,	2	–	2
Weymouth,	2	–	11	Southbridge,	2	–	2
Winchester,	3	3	9	Beverly,	2	1	3
North Adams,	6	2	8	Holyoke,	1	–	2
Adams,	2	3	7	Agawam,	2	–	2
Danvers,	3	7	1	Taunton,	1	1	2
Lowell,	5	6	2	Boston,	1	1	–
Watertown,	2	6	1	Marlborough,	1	1	1
Bedford,	1	6	7	Hyde Park,	2	1	1
Somerville,	3	2	7	Middleborough,	1	1	1
Amesbury,	4	–	6	Westford,	1	1	1
Springfield,	7	1	5	Natick,	1	1	–
Malden,	4	–	6	Belmont,	–	1	–
Salem,	3	2	12	Arlington,	1	1	–
Pittsfield,	2	–	5	Bradford,	2	1	–
Braintree,	1	2	5	Clarksburg,	–	1	–
Fitchburg,	2	3	4	Hingham,	–	1	–
Millbury,	3	3	2	East Bridgewater,	1	–	1
Holbrook,	1	–	4	Lawrence,	1	–	1

List of Cities and Towns from which Reports have been received relative to the Use of Antitoxin in the Treatment of Diphtheria, with the Number of Reports from Each and the Number of Physicians reporting in Each — Concluded.

Places.	Number Physicians reporting.	Cases in which Cultures were made.	Cultures were not made.	Places.	Number Physicians reporting.	Cases in which Cultures were made.	Cultures were not made.
Williamstown,	1	-	1	Attleborough,	-	-	1
New Bedford,	1	-	1	West Springfield,	-	-	1
Hinsdale,	-	-	1	Dalton,	2	-	1
Brockton,	1	-	1	Milford,	1	-	-
Wellesley,	-	-	1	North Attleborough,	1	-	-
Wrentham,	-	-	1	Tyngsborough,	1	-	-
Chicopee,	1	-	1	Total,	162	205	268

Cases in which a Bacterial Examination was made.

Following the same method of classification which was adopted in the report of the previous year, the cases in which cultures were made are classified into those which proved on examination to be cases of genuine diphtheria and those which did not; in other words, into positive and negative cases.

Diagnostic examinations by means of culture were made in 205 of the cases reported, and of these, 189 proved to be cases of genuine diphtheria and 16 gave a negative result.

Positive Cases.

Of the 189 cases, there were 167 recoveries and 22 deaths, or 11.6 per cent., — a slight improvement over the results of the previous year, which was 13.7 per cent.

Sex. — The number of males was 76 and the deaths of these were 11, or 14.5 per cent., which was almost identical with the 14.4 per cent. of the previous year. The females were 109, and the deaths of these were 9, or 8.9 per cent., as compared with 12.6 per cent. in 1895. The sex of four was not stated. Two deaths.

Ages. — The following table presents the cases and deaths by ages: —

Year ending March 31, 1897.

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.).
From 0 to 2 years,	17	3	17.6
From 2 to 5 years,	63	9	14.3
From 5 to 10 years,	47	7	14.9
Over 10 years,	60	3	5.0
Age unknown,	2	0	0.0
	189	22	11.6

Of those who were more than ten years of age, 33 were between ten and twenty, 16 were between twenty and thirty, 6 were between thirty and forty, 3 were between forty and fifty, 1 was 58 and 1 was of unknown age. Of the fatal cases in this class, 1 was eleven, 1 was twenty-three and the remaining 1 was forty-three years old.

Day of Illness when Antitoxin was first administered. — The following table presents the fatality, according to the day of illness on which antitoxin was first administered: —

Day.	Cases.	Deaths.	Fatality (Per Cent.). 1896.	Fatality (Per Cent.). 1895.
First,	22	0	0.0	0.0
Second,	42	4	9.5	9.7
Third,	36	3	8.3	8.7
Fourth,	22	5	22.7	15.4
Fifth,	6	0	0.0	22.2
Sixth,	7	1	14.3	20.0
Seventh,	4	1	25.0	33.3*
Eighth and later,	6	1	16.6	-

* Seventh day and later.

This table relates only to those cases in which a definite statement is given as to the day on which the antitoxin was first employed.

The small numbers in the lower part of this table have but little significance as compared with the larger numbers. They are retained, however, with the hope that the grouping of several years' experience will prove more valuable.

Fatality in Hospital and in Private Practice. — The fatality of the positive cases treated in hospitals was as follows: cases, 39; deaths, 2 = 5.1 per cent. In private practice: cases, 150; deaths, 20 = 13.3 per cent.

Seasons of the Year. — The cases embraced in the foregoing enumeration occurred in the following order: —

Months.	Cases.	Deaths.	Months.	Cases.	Deaths.
1896.			1896.		
April,	7	2	October,	24	4
May,	5	1	November,	27	2
June,	6	0	December,	25	0
July,	10	1			
August,	8	0	1897.		
September,	11	2	January,	28	3
			February,	19	3
			March,	19	4
	47	6		142	16

By this table it appears that there were 47 cases and 6 deaths among positive cases in the warmer months, and 142 cases with 16 deaths in the colder months.

Negative Cases.

The number of cases in which a negative result was obtained was 16. Two cases were excluded from the full number of 18 and placed in the group of positive cases, where the history and the clinical statement clearly indicated genuine diphtheria. There was also one case in which a negative result was obtained, in which the package, through the carelessness of an expressman, was frozen in its transit to the State House. There were no deaths among these 16 negative cases.

Summary of the Two Years, ending March 31, 1897.

Positive Cases treated with Antitoxin.

Whole number for the two years, 451; deaths, 58; fatality, 12.8 per cent.

Sex. — The fatality by sexes was as follows: —

Sex.	Cases.	Deaths.	Fatality (Per Cent.).
Males,	201	29	14.4
Females,	244	26	10.9

The sex of six was not stated.

Ages. — The fatality by ages was as follows: —

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.).
0- 2 years,	47	12	25.5
2- 5 years,	134	25	18.7
5-10 years,	138	16	11.6
Over 10 years,	127	5	3.9
Age unknown,	5	0	0.0
	451	58	12.8

Hospitals and Private Practice.

	Cases.	Deaths.	Fatality (Per Cent.).
In hospitals,	124	17	13.7
In private practice,	325	41	12.6

Cases in which no Bacteriological Examination was made.

Reports were made of 268 cases where antitoxin was employed, in which no cultures were taken. Out of this number there were 30 cases which proved fatal, or 11.2 per cent. of the whole. This number differs but little from that of 1895 for the same class of cases, that of 1895 having been 11.7 per cent. There were, however, 3 of the cases which occurred in this class in 1896 which may properly be rejected from consideration, since the patient was at the point of death in each case at the time of administration of the antitoxin. The following terms were employed in the returns in describing these cases: "moribund," "comatose," and "dying at the time of administration." It would, therefore, be proper to reject such cases as being beyond the power of remedial agencies of any sort. The rejection of these 3 cases, therefore, would reduce the number of cases to 265 and the deaths to 27, or 10.2 per cent.

Sex. — The number of males in this class was 111 and the deaths of these were 14, or 12.6 per cent. The number of females was 142 and the deaths of these were 13, or 9.2 per cent. The number of those whose sex was unknown or not stated was 12, and there were no deaths of these.

Ages. — The following table presents the cases and fatality by ages: —

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.).
From 0 to 2 years,	28	3	10.7
From 2 to 5 years,	83	15	18.1
From 5 to 10 years,	88	5	5.7
Over 10 years,	62	4	6.5
Age unknown,	4	0	0.0
	265	27	10.2

Of those who were over ten years old, 41 were between ten and twenty years, 10 were between twenty and thirty, 7 were between thirty and forty, 2 were between forty and fifty, 1 was sixty and another was seventy-three.

Day of Illness when Antitoxin was first administered.

The cases and deaths, distributed according to the day of illness when antitoxin was first administered, are presented in the following table: —

Day of Illness when Antitoxin was first administered.

Day.	Cases.	Deaths.	Fatality (Per Cent.).
First,	40	1*	2.5
Second,	54	2	3.7
Third,	25	3	12.0
Fourth,	27	6	22.2
Fifth,	11	2	18.2
Sixth,	9	2	22.2
Seventh and later,	12	5	41.7
Unknown,	87	6	9.0
	265	27	10.2

* This fatal case was that of a man thirty years of age, and of extremely intemperate habits. The reporter states that, in his opinion, the man would have recovered if it had not been for this fact.

Of the cases in which the administration was delayed until the seventh day or later, the antitoxin was used on the seventh day in 4 cases, on the eighth in 4, on the ninth in 1 case, on the tenth in 1 and on the fifteenth in 2 cases.

Hospitals and Private Practice.

The fatality among the private and hospital cases of this class was as follows: —

	Cases.	Deaths.	Fatality (Per Cent.).
Treated in hospitals,	43	2	4.7
Treated in private practice,	222	25	11.3
	265	27	10.2

Sequelæ.

In this summary all cases are considered together, those in which cultures were made and those in which none were made.

Eruptions. — Urticaria was reported as occurring in 60 cases, of varying severity and at greater or less intervals from the time of administration of antitoxin. In 16 cases it was noted as "slight," or at point of injection only; in 10 cases it was "copious," or generally distributed over the body; and in the remainder its severity was not specified. In several cases it appeared as early as the third or fourth day, and in 1 it was delayed till the eighteenth and in another till the twentieth day. It usually lasted from two to five days.

Albuminuria was reported in 51 cases. In 20 it was reported as "slight," or a "trace" only; in 3 it was severe, and attended with a fatal result; and in the remainder the character was not stated.

In 9 cases rheumatic pains and joint affections were reported.

In 9 cases paralysis of the throat was reported and in 2 paralysis of the legs.

Operations.

Of the foregoing cases, there were 22 in which operative interference was deemed necessary, and of these there were 17 in which intubation was performed, all of which recovered except 1. Nine of these were females, 7 were males and the sex of 1 was not stated. Their average age was three years and eleven months. One of these was intubated on the second day of illness, 2 on the third, 3 on the fourth, 4 on the sixth (1 fatal), 3 on the seventh, 1 on the eighth, and the time was not stated in 3 cases.

Tracheotomy was performed in 5 instances, 2 of which were fatal. All were females. One was two and one-half, 2 were four, another five, and the fifth was forty-three years old, and in the case of this adult the result was fatal.

The Brands of Antitoxin employed.

Since this report deals mainly with the antitoxin produced and offered for use to the local boards of health by the State Board of Health, it follows that the returns received upon the blank forms supplied by the Board present the results of its use. In a few instances, however, returns were received from parties who had, through inability to obtain the product supplied by the Board, or for other reasons, employed other brands, and in some cases two different brands were used in the treatment of single cases.

Deaths.

Private Practice.

1. Male, two years, two months (April, 1896). Weak and rapid pulse, 132; great prostration; membrane over tonsils and pharynx; hoarseness, dyspnœa and stenosis; glands normal. Antitoxin administered, 5 cubic centimeters; time not stated.

2. Male, five years (May, 1896). Temperature, 99°; pulse, 132, strong; condition at onset of illness excellent; membrane on posterior wall and left tonsil; hoarseness, cough, dyspnœa and stenosis; glands slightly enlarged; difficult breathing on fifth day. Antitoxin, 10 cubic centimeters; time not stated.

3. Female, eleven years (July, 1896). Temperature, 105°; pulse, 160, fairly strong; restless, weak and delirious; membrane on both tonsils, and increasing; neck glands swollen; all symptoms progressively worse. Antitoxin, 18 cubic centimeters, second day; 9 cubic centimeters, third day.

4. Male, seven years (September, 1896). Temperature, 101°; pulse, 140, weak; cyanotic; pale; prostration; membrane on posterior wall of pharynx, right tonsil, side of uvula and in the nose, and spreading; stenosis of larynx; copious epistaxis. Antitoxin, second day, 10 cubic centimeters in morning, 10 in afternoon and 10 on third day. Death on fourth day.

5. Female, eight years (September, 1896). Temperature, 102.5°; pulse, 100; patient irritable; membrane on both tonsils and part of soft palate; slight dyspnœa; right parotid gland enlarged; urine albuminous. Antitoxin, 7½ cubic centimeters. Death, thirteenth day.

6. Male, two and one-half years (October, 1896). Temperature, 99½°; pulse, weak; moderate prostration; membrane on tonsils and uvula;

hoarseness and cough; neck glands enlarged. Antitoxin, 5 cubic centimeters, sixth day; 5 cubic centimeters, seventh day. Death on ninth day.

7. Male, three years, two months (October, 1896). Temperature, 102°; pulse, 110, strong and regular; membrane on tonsils and fauces; hoarseness and cough; neck glands swollen, tender and tense; extreme prostration. Antitoxin (Behring's), 3 cubic centimeters, fourth day; 1 cubic centimeter (State Board of Health), fifth day, morning, 5 cubic centimeters, afternoon; 5 cubic centimeters, morning, sixth day. Death on seventh day.

8. Female, eleven months (October, 1896). Temperature, 105.2°; pulse, 80–180, weak; general condition poor; membrane on posterior wall, densely covered; dyspnœa and stenosis. Antitoxin, 6 cubic centimeters, repeated once; time not stated.

9. Male, five years (October, 1896). Temperature, 104°; pulse, 144; severe prostration; membrane in nose; hoarseness, cough, dyspnœa and stenosis; neck glands on left side much swollen; urine slightly albuminous. Antitoxin, 10 cubic centimeters, third day; 10 cubic centimeters, fourth day; 10 cubic centimeters, fifth day. Hemorrhages from mouth and nose on sixth day. Death on sixth day.

10. Male, four years (November, 1896). Temperature, 102°; pulse, 160, weak; severe prostration; neck glands enlarged; stenosis. Antitoxin, 600 units, morning, fourth day; 600, afternoon, fourth day; 600, sixth day. Death, eighth day.

11. Male, twenty-three years (November, 1896). Temperature, 103°; pulse, 120; great prostration; membrane on tonsils and palate; hoarseness, cough and dyspnœa; neck glands swollen. Antitoxin, 1,200 units, third day; 600, fourth day. Death, fifth day.

12. Female, five years (January, 1897). Temperature, 102°; pulse, 120, weak; membrane over tonsils and pharynx; hoarseness, cough, dyspnœa and stenosis; neck glands swollen. Antitoxin, two doses, 10 and 5 cubic centimeters; time not stated. Death thirty-six hours after first visit.

13. Male, eight years (January, 1897). Temperature, 103°; pulse, 90–132, regular and strong; great prostration; membrane on tonsils, uvula and soft palate and in the nose; slight stenosis; neck glands moderately enlarged. Drowsy, vomiting, and finally collapse and death on seventh day. Antitoxin, 4 cubic centimeters, morning, fourth day; 3 cubic centimeters, afternoon, fourth day; 3 cubic centimeters, fifth day; 5 cubic centimeters, sixth day.

14. Female, forty-three years (February, 1897). Pulse, weak; great prostration; very anemic; hoarseness, cough, dyspnœa and stenosis; urine pale, specific gravity 1,006, acid, trace of albumin, casts, puss and cells. Tracheotomy. Antitoxin, 1,000 units, fourth day; 1,000 units, fifth day; 1,000 units, seventh day. Death, ninth day.

15. Female, two years, ten months (February, 1897). Temperature, 97°; pulse, 80, very weak; marked toxæmia and profound prostration; urine suppressed; "when first seen, child was suffering from acute Bright's disease." Antitoxin, 800 units, seventh day. Death on eleventh day.

16. Male, seven years (February, 1897). Hoarseness, cough, dyspnœa and stenosis; pulse not very strong; neck glands enlarged; left lung finally involved. Antitoxin, 600 units, ninth day; 1,000, tenth day. Death, tenth day.

17. Sex not stated, ten years (March, 1897). Temperature, 99.8°; pulse, 130, weak and intermittent; great prostration; hoarseness, cough, dyspnœa and stenosis. Antitoxin, 1,000 units, fourth day. Death, fourth day.

18. Female, five years (March, 1897). Temperature, 101.8°; pulse, 130, extremely weak; membrane covering pharynx and in the nose; neck glands swollen. Antitoxin, second day, 1,000 units. Convulsions and death, third day.

19. Sex not stated, one year (March, 1897). Temperature, 104°; pulse, 130, strong; membrane on both tonsils and in the nose. Antitoxin, 1,000 units, third day. "Profuse bleeding from nose, causing death in a short time."

20. Female, six years (April, 1897). Pulse, 130; marked prostration; membrane on both tonsils and soft palate; neck glands enlarged; urine nearly suppressed for forty-eight hours before death. Antitoxin, 800 units; time not stated. Death, ninth day.

Hospital Cases.

21. Female, eleven months (January, 1897). Pulse, 120; prostration not excessive; membrane in pharynx; neck glands enlarged. Antitoxin, 1,000 units; time not stated. Death, thirty hours after injection.

22. Male, nine years (March, 1897). Great prostration; membrane over pharynx and roof of mouth and in the nose; neck glands very much enlarged. Antitoxin, 4,000 units, in divided doses; time not stated. Great improvement after each injection. Death from exhaustion on eighth day.

It is quite plain that a comparison of the fatality of cases treated with antitoxin with the general fatality of cases of diphtheria previous to the introduction of this therapeutic agent, or even with cases not treated with antitoxin, which occurred at the same period with those so treated, does not do justice to the merits of antitoxin, for the reason that such a comparison must be made between two groups or classes of cases which are not strictly comparable, since one con-

tains a larger and the other a smaller percentage of severe cases. That is to say, the general run of cases treated with antitoxin by physicians in private practice, and especially of those sent to hospital, must necessarily be a selected class, in which the percentage of severe cases is greater than it is in the whole number of cases of diphtheria occurring or reported in a given community.

It has been urged, and with some degree of reason, that the diminution in the fatality from diphtheria is partly due to the introduction of bacterial diagnosis by means of cultures from the throat, whereby mild cases of illness are shown to be cases of true diphtheria, which would otherwise have passed unnoticed. But this statement is in some measure offset by the fact that a considerable number of cases which might have passed for diphtheria before the days of bacterial diagnosis are now classed as "negative."

The present report gives support to the belief that the value of this argument has been over-estimated, since the cases in which cultures were made are here separated from those in which they were omitted, and the fatality in each group differs but slightly. This fact does not, however, in the least degree undervalue the importance of having a careful diagnosis made by means of cultures in each case, either before the administration of antitoxin, or as soon as possible after the beginning of treatment.

The most important lesson which is taught by these returns is the necessity of *early administration of the antitoxin in each and every case.*

Out of 136 cases in which antitoxin was administered on the first day of illness, there were only 2 deaths, or 1.5 per cent., and 1 of these deaths occurred in the case of an adult male who was stated to be a man of excessively intemperate habits and enfeebled by drink.

That this experience is not peculiar to Massachusetts is shown by the accompanying table, in which the effect of delayed administration is very conclusively demonstrated. In almost every collection of statistics of this character the fatality appears to increase with a considerable degree of uniformity from the first day onward.

As is usual in all similar tables of figures, the larger numbers present the more uniform results. From an inspection of this collection of more than 20,000 cases treated with antitoxin, the probability of recovery or of a fatal result in an average case may readily be estimated.

Comparison of Fatality from Diphtheria in Periods before and after Introduction of Antitoxin.

Place.	Before Introduction of Antitoxin.				After Introduction of Antitoxin.			
	Time.	Cases.	Deaths.	Fatality (Per Cent.).	Time.	Cases.	Deaths.	Fatality (Per Cent.).
German hospitals,*	1883 to 1894	157,724	42,178	26.7	April, 1895, to March, 1896,	9,581	1,489	15.5
Massachusetts,	1891 to 1894	13,332	3,768	28.3	April, 1895, to March, 1897,	989	117	11.8
England,†	1890 to 1894	71,003	17,315	24.4	– – –	–	–	–

* Arbeiten aus dem Kaiserlichen Gesund heitsamte, 13, 2, p. 254. Report of Dr. Dieudonné upon Antitoxin in German hospitals.

† Reports of Local Government Board, 1890-94.

Fatality by Ages.

Age Periods.	German Hospitals, 1895-96 (Per Cent.).	Massachusetts (Per Cent.).
0- 2 years,	39.1	23.5
2- 5 years,	15.3	17.4
5-10 years,	10.4	10.3
Over 10 years,	8.7	4.3
Unknown age,	16.9	9.1
All ages,	15.5	11.8

Day of Illness when Antitoxin was first administered.

Authority.	Cases.	Fatality (Per Cent.).	Day of Injection (Per Cent.).							
			First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Later than Sixth Day.	Day Unknown.
Welch,	1,489	14.2	2.3	8.1	13.5	19.0	29.3	34.1	33.7	17.6
Hilbert,	2,428	16.3	2.2	7.6	17.1	23.8	33.0	34.1	[illegible]	–
Collective inquiry of American Pediatric Society.	5,794	12.3	4.9	7.4	8.8	20.7	35.3	–	–	–
Austrian Health Board,	1,103	12.6	8.0	6.6	9.8	25.5	28.8	30.7	21.0	31.8
German Health Office,	9,581	15.5	6.6	8.3	12.9	17.0	23.2	29.0	[illegible]	24.1
Massachusetts State Board of Health (1895-96).	989	11.8	1.5	8.1	9.5	16.1	16.0	23.7	19.2	14.8

GENERAL SUMMARY, 1895 AND 1896.

Positive cases treated in the two years ending March 31, 1897, .	451
Cases in which no bacteriological examination was made, . .	538
	989*
Deaths of these, ...	117
Fatality (per cent.), ...	11.8

Sexes.

The number of males who were treated was	435
The number of females who were treated was	529
The number whose sex was not stated was	25
Total, ...	989*
Deaths of males, ...	57
Fatality of males (per cent.), ...	13.1
Deaths of females, ...	56
Fatality of females (per cent.), ...	10.6
Deaths, sex not stated, ...	4

Deaths by Ages.

AGE PERIODS.	Cases.	Deaths.	Fatality (Per Cent.).
0– 2 years, ...	85	20	23.5
2– 5 years, ...	288	50	17.4
5-10 years, ...	330	34	10.3
Over 10 years, ...	264	11	4.2
Age unknown or not stated, ...	22	2	9.1
Total, ...	989	117	11.8

Day of Administration.

DAY.	Cases.	Deaths.	Fatality (Per Cent.).
First, ...	136	2	1.5
Second, ...	223	18	8.1
Third, ...	158	15	9.5
Fourth, ...	144	26	18.1
Fifth, ...	50	8	16.0
Sixth, ...	38	9	23.7
Seventh and later, ...	52	10	19.2
Unknown, ...	231	34	14.8

* In this number (989) 43 cases in which a bacterial diagnosis showed negative results are not included, so that the whole number treated with antitoxin of which returns were made to the Board was 1,032.

DIPHTHERIA CULTURES EXAMINED DURING THE YEAR ENDING MARCH 31, 1897.

The following table presents the information obtained from the records of the Board relative to the number of diphtheria cultures examined during the year ending March 31, 1897, together with the names of the cities and towns for which this work was done and the numbers which proved to be positive and negative in each place.

Number of Cultures examined from April 1, 1896, to March 31, 1897.

	Positive.	Negative.		Positive.	Negative.
Abington,	-	1	Fitchburg,	38	26
Adams,	5	2	Foxborough,	-	1
Arlington,	3	3	Gilbertville,	1	-
Attleborough,	2	1	Hanover,	10	4
Ayer,	6	-	Harvard,	1	2
Baldwinville,	-	1	Haverhill,	15	20
Bedford,	3	5	Hingham,	20	11
Beverly,	80	48	Hyde Park,	31	14
Bolton,	1	2	Lancaster,	1	-
Boston,	1	1	Lexington,	9	1
Boxborough,	-	1	Malden,	2	2
Bradford,	2	1	Manchester,	1	-
Braintree,	1	-	Marblehead,	11	24
Brockton,	5	3	Marlborough,	17	16
Cambridge,	1	2	Medfield,	-	2
Chelsea,	44	19	Medford,	36	38
Clinton,	5	8	Melrose,	3	7
Cohasset,	2	1	Middleborough,	2	1
Cottage City,	1	-	Milford,	1	-
Danvers,	27	21	Milton,	22	10
Dedham,	2	2	Newburyport,	11	4
Everett,	108	90	New Bedford,	16	22

Number of Cultures examined from April 1, 1896, to March 31, 1897 — Concluded.

	Positive.	Negative.		Positive.	Negative.
Newton,	12	21	Tewksbury,	2	14
North Adams,	13	11	Townsend,	–	1
North Attleborough,	5	2	Wakefield,	15	17
Norwell,	9	3	Ware,	3	–
Norwood,	–	1	Warren,	2	1
Peabody,	1	1	Watertown,	32	22
Pittsfield,	–	1	Wellington,	–	1
Reading,	–	1	Westborough,	–	1
Rockland,	1	5	Westminster,	1	–
Roslindale,	1	1	Weymouth,	2	3
Salem,	33	30	Winchendon,	12	8
Saugus,	1	–	Winchester,	17	10
Shirley,	–	2	Winthrop,	5	1
Somerville,	80	70	Woburn,	6	4
Taunton,	7	13	Total,	804	686

In addition to the foregoing table another list is presented in which the information relates to those cultures which were examined in order to determine the question of the release of the patient from isolation or quarantine. The length of time during which the bacilli of diphtheria persisted is given in weeks.

Persistence of Diphtheria Bacilli in the Throat from the Date of the Earliest Symptoms (including all Cases where Cultures for Release were made, up to June 13, 1897).

Adams and North Adams.

1 case bacilli found at end of	1 week.
1 case bacilli found at end of	2 weeks.
4 cases bacilli found at end of	3 weeks.
1 case bacilli found at end of	5 weeks.
1 case bacilli found at end of	6 weeks.
8 cases.	

Beverly.

5 cases bacilli found at end of	1 week.
7 cases bacilli found at end of	2 weeks.
2 cases bacilli found at end of	3 weeks.
2 cases bacilli found at end of	4 weeks.
2 cases bacilli found at end of	5 weeks.
1 case bacilli found at end of	7 weeks.
1 case bacilli found at end of	8 weeks.
1 case bacilli found at end of	10 weeks.
2 cases bacilli found at end of	11 weeks.
23 cases.	

Chelsea.

4 cases bacilli found at end of	1 week.
3 cases bacilli found at end of	2 weeks.
4 cases bacilli found at end of	3 weeks.
11 cases.	

Danvers.

1 case bacilli found at end of	3 weeks.
4 cases bacilli found at end of	4 weeks.
1 case bacilli found at end of	5 weeks.
1 case bacilli found at end of	7 weeks.
1 case bacilli found at end of	8 weeks.
1 case bacilli found at end of	10 weeks.
9 cases.	

Everett.

8 cases bacilli found at end of	2 weeks.
12 cases bacilli found at end of	3 weeks.
10 cases bacilli found at end of	4 weeks.
2 cases bacilli found at end of	5 weeks.
2 cases bacilli found at end of	6 weeks.
4 cases bacilli found at end of	7 weeks.
2 cases bacilli found at end of	8 weeks.
1 case bacilli found at end of	9 weeks.
1 case bacilli found at end of	10 weeks.
1 case bacilli found at end of	13 weeks.
43 cases.	

Fitchburg.

5 cases bacilli found at end of	1 week.
7 cases bacilli found at end of	2 weeks.
2 cases bacilli found at end of	3 weeks.
2 cases bacilli found at end of	4 weeks.
2 cases bacilli found at end of	5 weeks.
1 case bacilli found at end of	7 weeks.
1 case bacilli found at end of	8 weeks.
1 case bacilli found at end of	10 weeks.
2 cases bacilli found at end of	11 weeks.

23 cases.

Hingham.

1 case bacilli found at end of	1 week.
4 cases bacilli found at end of	2 weeks.
6 cases bacilli found at end of	3 weeks.
4 cases bacilli found at end of	4 weeks.
1 case bacilli found at end of	5 weeks.
1 case bacilli found at end of	6 weeks.
1 case bacilli found at end of	7 weeks.
1 case bacilli found at end of	10 weeks.

19 cases.

Hyde Park.

2 cases bacilli found at end of	2 weeks.
2 cases bacilli found at end of	3 weeks.
4 cases bacilli found at end of	4 weeks.
4 cases bacilli found at end of	5 weeks.
2 cases bacilli found at end of	6 weeks.
1 case bacilli found at end of	7 weeks.

15 cases.

Lexington.

1 case bacilli found at end of	2 weeks.

Marblehead.

1 case bacilli found at end of	2 weeks.
2 cases bacilli found at end of	4 weeks.

3 cases.

Marlborough.

1 case bacilli found at end of . . . . 3 weeks.
1 case bacilli found at end of . . . . 4 weeks.
1 case bacilli found at end of . . . . 5 weeks.
2 cases bacilli found at end of . . . . 7 weeks.
—
5 cases.

Milton.

1 case bacilli found at end of . . . . 1 week.
3 cases bacilli found at end of . . . . 2 weeks.
2 cases bacilli found at end of . . . . 3 weeks.
—
6 cases.

New Bedford.

3 cases bacilli found at end of . . . . 2 weeks.
2 cases bacilli found at end of . . . . 3 weeks.
—
5 cases.

Norwell.

1 case bacilli found at end of . . . . 3 weeks.
1 case bacilli found at end of . . . . 19 weeks.
—
2 cases.

Salem.

4 cases bacilli found at end of . . . . 1 week.
3 cases bacilli found at end of . . . . 2 weeks.
3 cases bacilli found at end of . . . . 3 weeks.
1 case bacilli found at end of . . . . 5 weeks.
—
11 cases.

Somerville.

5 cases bacilli found at end of . . . . 2 weeks.
4 cases bacilli found at end of . . . . 3 weeks.
2 cases bacilli found at end of . . . . 4 weeks.
1 case bacilli found at end of . . . . 5 weeks.
—
12 cases.

South Hanover.

1 case bacilli found at end of . . . . 3 weeks.

Taunton.

2 cases bacilli found at end of	1 week.
3 cases bacilli found at end of	2 weeks.
5 cases bacilli found at end of	3 weeks.
2 cases bacilli found at end of	4 weeks.
1 case bacilli found at end of	5 weeks.
1 case bacilli found at end of	6 weeks.
1 case bacilli found at end of	8 weeks.
1 case bacilli found at end of	9 weeks.
2 cases bacilli found at end of	14 weeks.

18 cases.

Winchester.

1 case bacilli found at end of	2 weeks.
1 case bacilli found at end of	11 weeks.

2 cases.

Watertown.

1 case bacilli found at end of	1 week.
1 case bacilli found at end of	2 weeks.

2 cases.

The following circular of information was issued by the Board and sent to local boards of health throughout the State: —

The Diagnosis of Diphtheria by Means of Cultures.

[A Circular of the State Board of Health of Massachusetts.]

The term "diphtheria" is now by common consent confined to those affections of the throat, nose, larynx and trachea which are associated with the bacillus of diphtheria. Affections resembling diphtheria clinically, but not traceable to diphtheria bacilli, appear to be common. According to extended studies, especially those of Park of New York, the mortality of such affections is quite low. The importance of determining promptly in all throat affections whether the diphtheria bacillus is present or not is threefold.

1. The use of antitoxin is not infrequently based upon the diagnosis, although in all cases which begin with threatening symptoms, and which the physician considers, clinically, as diphtheria, it is far wiser to use the antitoxin at once rather than wait twenty-four hours.

2. A more important use of a correct diagnosis is in the application of measures designed to prevent the further spread of diphtheria to the healthy members of the afflicted household and to children in school.

3. At the present time it is further desirable to collect accurate statistical evidence of the efficacy of the antitoxic serum, and this evidence is not valuable unless the nature of the cases treated with it is definitely known. This is clear from the fact that antitoxic serum is directed only against affections produced by the bacillus of diphtheria, and, so far as known, it has not the power of neutralizing the products of other poisonous pathogenic bacteria.

The Massachusetts State Board of Health is now prepared to make the diagnosis of diphtheria by means of cultures. The method adopted is that first introduced into New York city by its board of health. A box containing a culture tube and a swab is sent out. The attending physician prepares the culture in accordance with printed directions accompanying every box. After the culture tube has been inoculated from the throat of the patient and the accompanying blank filled out, both are returned without delay by express or messenger to the State Board of Health, Room 141, State House, Boston.

The cultures, under favorable conditions, will be ready for examination on the morning after the receipt of the box, and a message will be sent out as soon as the examination has been completed. A telegram or telephone message will be sent if so desired, but it is expected that all express, telegraph and telephone charges will be at the expense of the local boards of health or physicians from whom the requests for bacteriological examinations are received.

The success of the diagnosis will depend largely upon the care exercised by the physician in making the inoculation. The directions accompanying the tubes should be consistently followed out, and a special effort should be made to bring the swab in contact with any existing exudate. The failure of the culture may be due to a number of causes. The membrane may be low down, beyond the reach of the swab;* antiseptics may have been applied to the throat shortly before the culture was made; the culture medium used may be too old and too dry to favor the growth of the implanted bacteria, or it may have been contaminated with bacteria before use. The dryness of the nutrient serum shows itself by a *marked* concavity of the surface to be inoculated (a slight concavity being usually present), any foreign growth, by spots on the smooth, whitish surface of the serum. Such tubes should not be used if others are accessible, but returned promptly. The physician inoculating the tube may injure the culture by careless, clumsy handling of the swab, thrusting it into the culture

* In cases of membranous croup the diphtheria bacilli are more likely to be found in cultures from the throat later on in the disease, probably because they have been coughed up.

medium and breaking it up instead of gently rubbing it over the surface. The accuracy of the culture diagnosis thus depends largely on the physician inoculating the tube, and it would be to the advantage of all concerned if the suggestions herein contained and the directions accompanying the box were carefully studied before the culture test is made.

The bacteria encountered on the mucous membranes of the throat are of several kinds: (1) micrococci (staphylococci and streptococci), usually regarded as the cause of the mild, non-diphtheritic anginas, and present to a greater or less extent in all throats; (2) bacilli not easily distinguishable from the true diphtheria bacilli and usually denominated pseudo-diphtheria bacilli; and (3) the genuine diphtheria bacilli.

It is not contemplated by this service to furnish a guide for the use of diphtheria antitoxin, because of the delays which may be anticipated in the transmission of the boxes from one portion of the State to another. The object of the culture diagnosis will be to supply the physician or health officer with a more reliable guide than can be furnished by the clinical diagnosis in preventing the spread of the disease through the household and thence into the community. Until information has been received, suspected cases should always be treated as true diphtheria, and the precautions taken which are laid down in another circular of information on this disease relative to isolation and disinfection. The administration of diphtheria antitoxin should not be delayed until the return notice has been received if the case is one which arouses apprehension, since the efficacy of the serum diminishes with the progress of the malady.

The persistence of diphtheria bacilli in the throat of recovered persons has been frequently demonstrated, and it has now become customary in cities to examine the throat after recovery to determine whether or not the infectious agent is still present. If diphtheria bacilli are found, the person is still in a position to disseminate the disease. The period of time following the disappearance of the membrane during which the bacilli are still present varies from case to case. They may be absent on the day following the disappearance of the membrane, or they may be detected for weeks thereafter.

Cultures designed to reveal the presence of diphtheria bacilli after the subsidence of the disease will be examined in special cases if desired by the health authorities immediately concerned. In all cases it is highly desirable to keep children out of school for at least two weeks after recovery, and to warn older convalescents not to kiss children and to guard themselves for several weeks against any act which would favor the direct or indirect transfer of bacteria from their mouths to those of others.

STATE HOUSE, BOSTON, March, 1896.

[Copy of blank form provided with each culture outfit.]

DIPHTHERIA.

No.
City or town,
Name of patient, Age,
Name of physician,
Address of physician,
Date and hour of culture,
Date of earliest symptoms,
Location of exudate,
Any local application shortly before inoculation of culture tube?
Source of infection,
Clinical diagnosis,

(Return both tubes with swab and this schedule filled out.)

RETURN BOX BY EXPRESS ONLY.

All charges of transmission must be paid by the local authorities or by the persons who forward the packages. *It will facilitate the work of diagnosis if local boards and physicians will inform the State Board as to the mode of replying, i. e., by mail, telephone or telegraph.*

In order to ensure promptness in replying, it is desirable that culture tubes should be left at the office of the Board, Room 141, State House, between 9 A.M. and 4 P.M., and on Saturdays before 1 P.M.

MALARIA.

The prevalence of malaria in certain portions of this State for some years past, its persistence in some of these localities and the endemic character which it is beginning to assume make the possession of more accurate knowledge concerning its genesis and diffusion a thing greatly to be desired.

The hypotheses hitherto held concerning the origin of malaria in temperate climates, such as proximity to stagnant waters and the upturning of the soil, undoubtedly are conditions necessary to its genesis, but there are other unknown factors which only future observation and study can bring to light. Until these are known, and thereby the chain of events which mark the various steps in the life history of the malarial parasite completed, we are exposed to the danger of misinterpreting the significance of the conditions now known and giving them either too great or too little value in combating the disease.

The necessity for more information is thus evident. To obtain this from different parts of the State, the interest of physicians must be aroused and their service enlisted. Only the practising physician is likely to become cognizant of cases of this ephemeral and sporadic disease. He, also, is likely to overlook it because of its apparently slight importance or to confound other ailments with it. Not infrequently it is dealt with in silence on account of the fear that a knowledge of its prevalence would injure the attractiveness and prosperity of the infected locality. It is not improbable that a complete knowledge of the genesis of malaria will, by showing all the factors involved, relieve just such localities or communities of the odium involved, because it must show a way out of the difficulty. Co-operation in such investigation is therefore the duty of precisely such localities as are most afflicted, because the facts there obtainable are best adapted to a successful study of the causation.

In order to accomplish the object of gathering information and at the same time assisting the physicians and removing the facts collected from the domain of guesswork, the microscopic diagnosis of malaria by an examination of the blood was made a part of the regular work of the laboratory. In order to bring this work to the notice of physicians and to instruct them in the method of preparing the blood films the following circular was distributed: —

OFFICE OF STATE BOARD OF HEALTH.

THE DIAGNOSIS OF MALARIA.

The evident encroachment of malarial diseases upon new territory and the intensification of the infection in certain localities make it of importance to search more thoroughly than has been done heretofore for the primary factors concerned in the dissemination of these diseases.

To accomplish this purpose in part an accurate knowledge of the distribution of malaria is necessary. This requires the elimination of diseases or conditions often called malarial which are due to other causes, and, on the other hand, the recognition of cases of malaria now and then overlooked when the symptoms are not sufficiently typical.

In pursuing the investigation of malaria the State Board of Health proposes to make diagnoses of this disease whenever called upon to do so. Since it has been definitely shown that the different types of malarial fever are always associated with certain minute organisms within the red corpuscles of the blood, the method of diagnosis is restricted to the microscopic examination of this fluid. The following procedure will be used: —

Cover-glasses, in small boxes, will be mailed on application to all those who may expect to meet malaria during the warm season. These are to be used in collecting a small amount of blood from the suspected case and forwarding it to Room 141, State House, Boston.

The blood films are prepared in the following manner: —

The tip of a finger or the lobe of one ear is thoroughly cleansed with soap and water and dried carefully. If desired, the part may also be washed with alcohol and ether to remove any remaining scales or oily matter. An ordinary surgeon's needle, previously passed through the flame of an alcohol lamp or a gas burner or held over the chimney of a kerosene lamp for a few seconds to sterilize it, is used to prick the part until a small drop of blood exudes. This may be wiped away with a clean cloth and the second drop used. This is touched with the edge of a cover-glass and the edge carrying the drop placed on a second cover at an angle of 20 to 30 degrees and drawn across its entire face. A thin film of blood will be deposited on the second cover which dries rapidly. *Three* or *four* such films should be

prepared if possible, each one from a freshly exuding drop, and laid down to dry. A slight manipulation of the part pricked will cause the blood to continue to ooze from the same puncture until the necessary preparations have been made. The points to be borne in mind in this operation are great cleanliness, rapidity of work and the use of a fresh drop of blood, as the corpuscles shrivel soon after exposure to the air. Everything should be put in readiness and within reach before the skin is pricked, to avoid delay in making the films.

The film should be very thin so that the corpuscles may be fixed almost instantly on the glass by drying. The thinner the film, other things being equal, the more perfect the preservation of the corpuscles. A thin film cannot be obtained from a large drop of blood, hence the operator should not wait until the exuding drop becomes too unwieldy. It is better to wipe away a large drop and work with the following smaller one. When the cover-glasses are thoroughly dry — and this should not require more than fifteen to thirty seconds — they are wrapped separately in the paper provided and replaced in the box. This should be filled with the paper so that the glasses cannot move about.*

Slides may be used in place of cover-glasses by those preferring them. The manipulation is the same as with cover-glasses. The edge of one, charged with the drop of blood, is drawn rapidly but steadily over the face of the other at an angle of 20 to 30 degrees. The slides must be scrupulously clean. Drawing them rapidly through a flame often destroys the film of grease when other means have failed to remove it. The edges of the slide which receives and distributes the blood should be ground, or, at any rate, very even, otherwise the film will be imperfect.

The best time for taking the blood is during a chill, or, in doubtful cases, when the suspicious symptoms are most pronounced. Since quinine has a destructive effect upon malarial parasites, films prepared *after* the administration of this drug may not contain these organisms in numbers sufficient to be detected and the microscopic diagnosis may be misleading.

The accompanying blank should in all cases be filled out and returned with the preparations of blood.

State House, Boston, May, 1896.

The blank which is to be filled out contained the following queries: —

---

* Physicians are cautioned against laying covers together with the drop of blood between them and sending them in this condition. Nor should they be placed together, face to face, and then drawn apart, as for some kinds of bacteriological work.

MALARIA.

1. No.
2. Locality,
3. Name of patient, Age,
4. Name of physician,
5. Address of physician,
6. Symptoms of the case,
7. Probable source of infection if any suspected,
8. Date of season of last former attack, if any,
9. Date of preparations and relation in time to chill, if any,
10. Any quinine or other medicine administered before preparation of films,

Remarks:

Of these questions Nos. 8 and 9 deserve a passing notice. In tracing the distribution of malaria it is evidently necessary to distinguish between patients who have never before been affected and those who have had attacks before. Since the malarial parasite very probably lives in the blood for a variable or indefinite period of time after the symptoms of an attack have passed by, the renewed outbreak of the disease must not be interpreted necessarily as a fresh infection although it may be. The past history of the patient should therefore be carefully noted. Since the blood parasite varies in size and appearance at different intervals after the chill or paroxysm, the microscopist should know how many hours after the last or before the expected chill the blood films have been prepared, so as to be guided by this information during the examination.

In response to this circular preparations from 57 patients have been sent in for examination between April 1, 1896, and April 1, 1897. The experience gained in looking over these preparations, as well as those sent in before and after the year as limited above, has revealed certain difficulties of a minor character. In the first place, the microscopist is limited to the blood films taken at some one moment and is unable to repeat the examination if desirable, as is the case in hospitals and private practice. If the preparations have been hastily made or without following carefully the directions given the blood films are frequently of little or no use. Again, the physician, being called usually during a chill, is not likely to reach the patient until this has subsided. The blood films sent are thus usually made soon after a chill, when the recognizable parasites are fewest and smallest in the whole cycle between consecutive chills. But this is not a serious obstacle and the diagnosis can, as a rule, be made.

The result of the examination of the preparations is best shown in the following table: —

	Number of Patients.	Positive.	Negative.
Ayer,	2	1	1
Dorchester,	1	1	–
East Douglas,	3	–	3
Everett,	1	–	1
Hyde Park,	5	–	5
Leicester,	1	–	1
Northbridge,	1	1	–
Norwood,	1	–	1
Uxbridge,	41	24	17
Waltham,	1	1	–

Of preparations from 57 patients those from 28 contained malarial organisms. Lest this low percentage of positive cases might be used as a witness against the efficiency of the method it should be stated that among these cases are

1. Several who were affected with some other malady but upon which the physician hoped to get light from the examination of the blood.
2. A number of cases in which the physician himself failed to make a positive diagnosis from the clinical side.
3. A considerable number in which quinine had been given before the preparation of the films.
4. One old case without symptoms.
5. Five cases examined in midwinter.
6. A certain number from which imperfect films were received. These though somewhat doubtful were classed as negative.

A further analysis of these cases will not be attempted at the present time but left until more material has accumulated. Such analysis, however, would show that in from 5 to 10 per cent. of all the cases examined the diagnosis was of great value to the physician in charge in clearing up at once the obscure character of the malady.

EXAMINATIONS

OF

SPUTUM AND OTHER MATERIAL SUSPECTED OF CONTAINING THE BACILLI OF TUBERCULOSIS.

EXAMINATIONS OF SPUTUM AND OTHER MATERIAL SUSPECTED OF CONTAINING THE BACILLI OF TUBERCULOSIS.

The following table presents the results of examination of sputum and other material forwarded to the Board from different cities and towns for the purpose of determining the presence or absence of the bacilli of tuberculosis.

The whole number of specimens examined was 124 and the results were as follows: —

Tabular Statement of Examinations made by the Board for determining the Presence or Absence of the Bacilli of Tuberculosis in Sputum or Other Material presented for Such Examination.

Town.	Number of Cases Examined.	Males.		Females.		Sex not Stated.	
		Positive.	Negative.	Positive.	Negative.	Positive.	Negative.
Abington, ...	2	–	2	–	–	–	–
Adams, ...	5	–	1	2	2	–	–
Arlington, ...	7	2	1	1	2	1	–
Attleborough, ...	5	1	2	2	–	–	–
Boston, ...	2	1	–	–	1	–	–
Brockton, ...	5	–	2	–	1	1	1
Canton, ...	1	1	–	–	–	–	–
Chelsea, ...	1	1	–	–	–	–	–
Cambridge, ...	2	–	–	1	1	–	–
Clinton, ...	1	–	–	–	–	–	1
Danvers, ...	12	1	2	3	3	2	1
Dedham, ...	1	1	–	–	–	–	–
Everett, ...	8	–	4	1	1	2	–
Fall River, ...	1	1	–	–	–	–	–
Fairhaven, ...	1	–	–	–	–	1	–
Franklin, ...	2	1	1	–	–	–	–
Hyde Park, ...	1	–	–	–	–	1	–
Haverhill, ...	5	1	2	1	1	–	–
Hanover, ...	1	–	–	1	–	–	–
Malden, ...	1	–	–	–	–	–	1
Melrose, ...	2	1	–	1	–	–	–
New Bedford, ...	25	6	5	4	9	1	–
Norwood, ...	2	–	1	–	1	–	–
Newton, ...	1	–	–	1	–	–	–
Peabody, ...	1	–	1	–	–	–	–
Rockland, ...	9	2	1	1	5	–	–
Salem, ...	2	1	–	1	–	–	–
Stoneham, ...	2	1	–	–	1	–	–

Tabular Statement of Examinations made by the Board for determining the Presence or Absence of the Bacilli of Tuberculosis in Sputum or Other Material presented for Such Examination — Concluded.

Town	Number of Cases Examined.	Males.		Females.		Sex not Stated.	
		Positive.	Negative.	Positive.	Negative.	Positive.	Negative.
Somerville,	1	1	–	–	–	–	–
Taunton,	1	–	–	1	–	–	–
Uxbridge,	3	–	–	1	2	–	–
Watertown	1	–	–	1	–	–	–
Ware,	4	2	1	1	–	–	–
West Bridgewater,	1	–	–	1	–	–	–
Wrentham,	1	–	–	1	–	–	–
Woburn,	2	–	2	–	–	–	–
Weymouth,	1	–	–	–	1	–	–
Winchester,	1	–	–	–	1	–	–
	124	25	28	26	32	9	4

Distribution by Ages.

	Number of Cases.	Positive.	Negative.
Between the age of 1-10,	4	1	3
Between the age of 10-20,	9	2	7
Between the age of 20-30,	34	20	14
Between the age of 30-40,	20	7	13
Between the age of 40-50,	20	13	7
Between the age of 50-60,	3	2	1
Between the age of 60-70,	1	–	1
Between the age of 70-80,	1	–	1
Ages unknown,	32	16	16
Total,	124	61	63

Distribution by Sexes.

	Total.	Males.	Females.	Sex Unknown.
Number cases examined (positive),	60	25	26	9
Number cases examined (negative),	64	28	32	4
Total,				124

A circular was issued to local boards of health containing the necessary information upon this point, of which the following is a copy: —

OFFICE OF STATE BOARD OF HEALTH, November, 1896.

THE EXAMINATION OF SPUTUM FOR TUBERCLE BACILLI.

The microscopic examination of sputum for tubercle bacilli will be made by the State Board of Health for those desiring it. A small quantity, preferably not more than one-half ounce, should be sent in a small, wide-mouthed bottle, suitably protected against breakage, by express or messenger to Room 141, State House, Boston.

Small glass receptacles, properly packed, will be sent on application.

To ensure material for a satisfactory diagnosis, the patient should be requested to reserve only that sputum which is coughed up from the air tubes and lungs and to reject secretions from pharynx and throat. To do this the throat should be thoroughly cleared first, and only the masses subsequently expectorated reserved.

Since tubercle bacilli are quite resistant, and demonstrable in sputum for some time after it has been expectorated, any great haste in sending it is not called for. It should, however, be sent as promptly as possible, especially in warm weather.

The object of the examination of sputum is not so much to enable the physician to make an early diagnosis as to protect the public from manifestly infectious sputum. The Board does not hold itself responsible, therefore, for the occasional non-discovery of tubercle bacilli when they are present in very small numbers.

The repeated and varied examination of sputum found free from bacilli after the usual methods of staining have been carefully applied will not be undertaken excepting under certain not at present definable conditions.

Examination of sputum for special morphological constituents, for pneumonia and influenza germs, is also beyond the scope of this work, and will only be undertaken when the public health warrants it.

The following blank form should be filled and returned with each specimen forwarded to the office of the Board: —

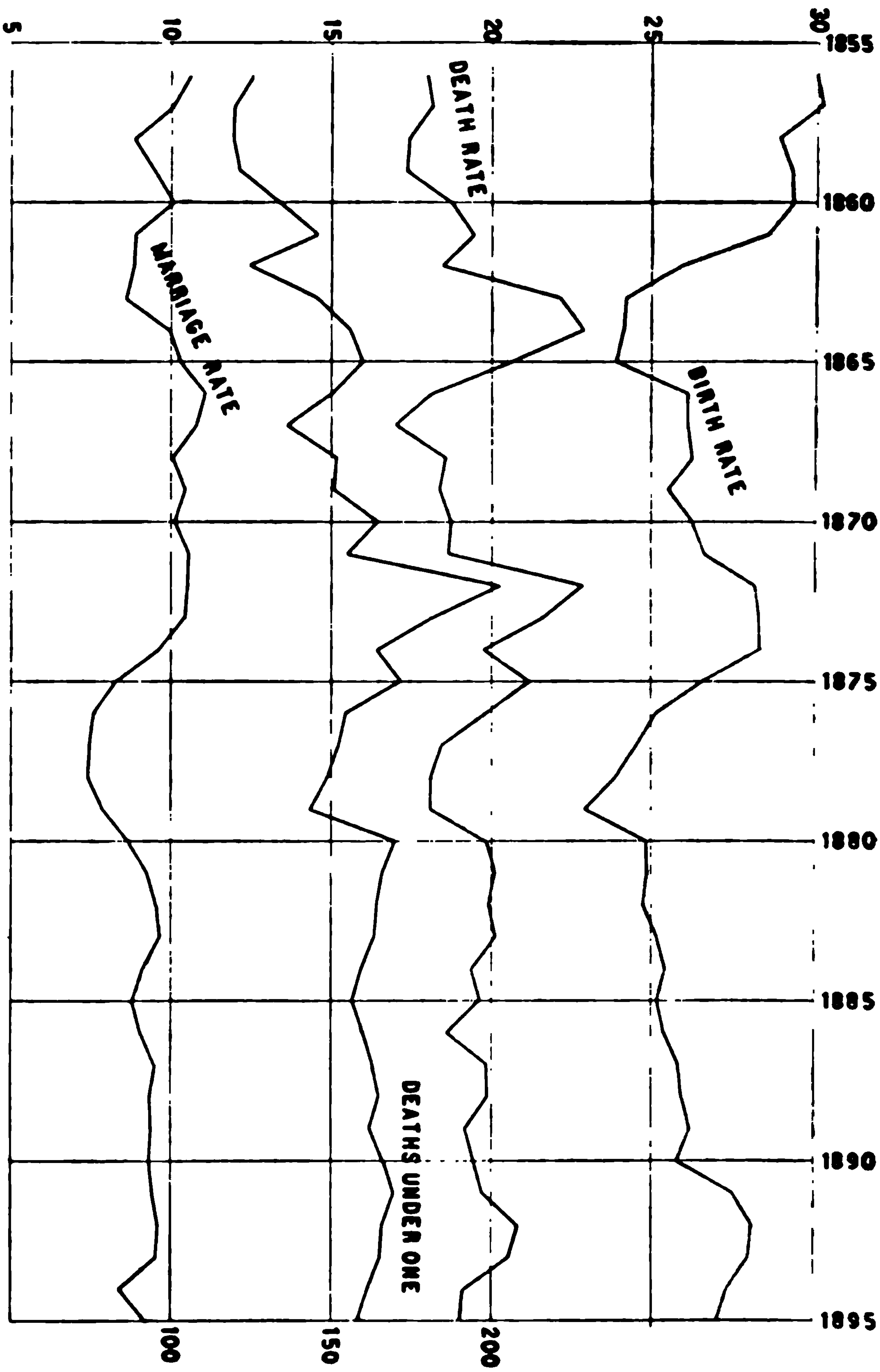
TUBERCULOSIS.

1. No.
2. Name of patient, Age,
3. Address,
4. Occupation,
5. Name and address of attending physician or of sender,
6. Sputum, when discharged,
7. Clinical diagnosis,
8. Duration of disease,
9. Any other cases in the same household?
10. Remarks:

THE

VITAL STATISTICS OF MASSACHUSETTS,

1856-95.



Marriage, Birth and Death-rates and Infantile Death-rate, Massachusetts, 40 Years, 1856-95.

NOTE.—The birth, death and marriage rates are indicated by the first, second and fourth irregular lines in the diagram, and represent the ratio per thousand of the living population, the scale being at the left side of the diagram. The infantile death-rate is shown by the third irregular line, and represents the ratio of the deaths under one to the living births per thousand; the scale for this line is at the right side of the diagram.

THE VITAL STATISTICS OF MASSACHUSETTS.

A FORTY YEARS' SUMMARY.

By SAMUEL W. ABBOTT, M.D., *Secretary of the Board.*

The occurrence of a census year affords an opportunity for the presentation of the vital statistics of a community with more than usual accuracy. Each census year forms a milestone or point of departure in the life history of the State, and the data collected in such a year may be used as standards of reference from which, with proper limitations, conclusions may be formed with a degree of certainty which cannot be applied to the statistics of intervening years.

In the present summary of the marriages, births and deaths which occurred in the forty-year period, 1856–95, the methods employed are similar to those which were adopted in the brief summaries of the statistics of 1893 and 1894,* but with greater fulness of detail, especially in those particulars which are of the greatest interest and value to physicians and health officials.

Dr. Longstaff, in commenting on the value of vital statistics, says: "The numerous and very voluminous reports on the very dusty shelves of the library of the Statistical Department of the General Register Office form a vast reservoir, into which a ceaseless stream of facts has been flowing for more than half a century."

The usefulness of these myriads of facts, which likewise in Massachusetts have been accumulating for more than half a century, depends largely upon the carefulness and the clearness with which the compiler treats them, and upon the judicious selection which he makes of the material in his possession.

First in order in the present summary the subject of population is presented, since upon the number and distribution of the population by sexes, ages, races and density depends very largely the value of the observations which are made. Absolute numbers have a definite

* Published in the twenty-sixth and twenty-seventh annual reports of the Board.

value, but this value is very much enhanced when relative numbers are also given, such, for example, as the ratio obtained by comparing the deaths from any disease at any age of life with the numbers of the living at the same age.

The order in which the statistics are presented (marriages, births and deaths) has been adopted in conformity with the general usage of nearly all countries having systems of registration, and because it represents the order of events in each family, natural as well as sociological.

In earlier periods of New England history the county was considered as an important factor, but at the present time the county, statistically considered, is of much less importance, while the city and the urban population are yearly assuming greater interest as the relative numbers of the urban population increase. In 1842, the first year of registration, the population of towns in the State having 10,000 inhabitants in each, constituted only 24 per cent. of the population. In 1895 the population of this class had increased to 69 per cent. of the whole. Hence county statistics will be but little used in this summary.

Of the Accuracy of the Material collected for Publication in the Massachusetts Registration Reports. — The period of forty years (1856–95) has been selected for consideration for the reason that it presents a definite portion of time in which the returns of vital statistics of the cities and towns may be deemed to be fairly accurate. The returns of the first few years following 1842 are more or less incomplete and untrustworthy, but those of the forty years under consideration must be considered as approximately correct.

With reference to a very important portion of the returns, that which relates to the causes of death, the following comments of Dr. Longstaff upon the registration reports of England are so fully applicable to our own statistics that we take the liberty to quote them nearly *verbatim* : —

I have been more and more convinced of the value of the figures, and fully believe that they may be taken as, on the whole, a fair approximation of the truth. At the same time it is hardly necessary to say that, like all other statistics, they require care and knowledge in handling. Without doubt the figures relating to alcoholism, venereal diseases and perhaps insanity are almost valueless; but that does not prove that those relating to scarlet-fever, pneumonia or cancer are equally valueless. Neither does the fact that a large number of certificates are carelessly filled invalidate

the far larger number that are more trustworthy; indeed, those very sources of error are subject to laws, and are more or less constant factors of the whole. When it is possible, as I have elsewhere proved it to be, to find general laws regulating many of the causes of death, and especially mutual relations between these causes, and relations between some of them and various external phenomena, the only possible inference that I can deduce is that the figures dealt with are the expression, more or less accurate, of facts in nature. . . .

But in spite of what I have just stated, it must be admitted that there are numerous fallacies to which the classification of deaths according to their alleged causes is liable. They are: —

1. In a number of cases no cause of death is specified at all.

2. (And this is a much more important source of error.) In a large number of cases the cause is stated in such a vague or indefinite manner as to be almost valueless. The terms "atrophy," "debility," "old age," "hemorrhage," "dropsy," etc., give but little information, but it is satisfactory to note that from the beginning of the reports to the last issued the improvement in this respect is steady and continuous. For example, very few cases are now returned simply as "dropsy," but the dropsy is referred to disease of the heart, kidneys, liver or ovaries.*

3. Where the cause is definitely assigned, there is good reason to believe that, in a large number of cases, owing to carelessness, ignorance or desire to spare the feelings of relatives, or even less worthy motives, the causes of death assigned are barely approximately correct. The returns themselves indicate that this source of error is also diminishing.

To the foregoing should also be added the fact, stated somewhat differently by Dr. Longstaff, that medicine is a progressive science, and that the frequent discoveries in relation to the natural history of diseases necessitate changes in the terms employed to designate them. New terms are introduced in every decade, and the nomenclature and classification of one half century are replaced by an entirely new system in the next half century.

The sum of the individual records treated in this summary for the forty years, 1856–95, is as follows: —

Marriages,	630,680
Births,	1,780,872
Deaths,	1,317,453
Still births,	56,005
Total,	3,785,010

* The deaths certified in Massachusetts as from dropsy in 1856 were 487. Those in 1895 were 88.

POPULATION.

Population constitutes the natural basis of vital statistics and hence should first be considered in the treatment of the subject.

Growth of the Population.

There are two factors which affect the movement of the population, either in an increasing or a diminishing ratio. First, the difference between the births and deaths, and second, the difference between the number of immigrants and the number of emigrants.

The growth of population, consisting in the excess of the births over the deaths is usually termed the natural increase, while that which consists in the excess of immigrants over emigrants cannot be properly termed an increase, but is merely a transfer from one country or community to another.

The first ship's company of a few score persons who landed at Plymouth in 1620, notwithstanding an enormous death-rate in the first few years, had increased in one hundred and forty-five years to 239,764, according to the first colonial census of 1765, but this increase was made up for the most part of new arrivals from beyond the sea, and not from the excess of births over deaths.

During the forty years comprised in the present report (1856–95) the population of the State more than doubled, the increase from the census of 1855 to that of 1895 amounting to 1,367,814, but of this number, 904,395, or nearly two-thirds, consisted of immigrants from other States and countries, since the excess of births over deaths during these forty years amounted to only 463,419. The growth of population, therefore, in the past forty years may be said to consist of the excess of births over deaths, and the migration, in the ratio of about one of the former to two of the latter.

In the following table (1) are presented the enumerated populations in each of the years in which a census was taken (either colonial, State or national). The annual rates of increase at each intercensal period varied from a minimum of .58 of 1 per cent. annually in the period of civil war, to a maximum of 3.03 per cent. in the period 1840–50.

Sex. — In the next table (2) is presented the population at each census by sexes, together with the percentage of each sex, and the ratio of females to 1,000 males, by which it is shown that the females have invariably been in excess at each census enumeration, the least

difference occurring at the census of 1840, when the females were in the ratio of 1,019 to 1,000 males, and the greatest difference being in 1865, when the females were in the ratio of 1,105 to 1,000 males. This census was taken just at the close of the war, but while a considerable portion of the troops had not yet returned home.

If the growth of population in Massachusetts be reckoned by centuries, it may be said to have increased in the seventeenth century, in the eighty years, 1620 to 1700, from 0 to about 100,000 in round numbers, in the eighteenth from 100,000 to 422,845 (one hundred years), and in the nineteenth from 422,845 to 2,500,183 (ninety-five years).

The descendants of the Indians of Massachusetts are now less than 800 in number, and are mostly, if not all, of mixed blood.

TABLE 1.— *Population of Massachusetts and Annual Rates of Increase (Geometric), 1765-1895, compiled from Colonial, United States and State Census Reports.*

Years and Character of Each Census.	Population.	Annual Rate of Increase.
Colonial, 1765,	239,764	
Colonial, 1776,	299,841	2.05+ per cent.
United States, 1790,	378,787	1.68+ per cent.
United States, 1800,	422,845	1.11 per cent.
United States, 1810,	472,040	1.11 per cent.
United States, 1820,	523,287	1.04 per cent.
United States, 1830,	610,408	1.55+ per cent.
United States, 1840,	737,700	1.91+ per cent.
United States, 1850,	994,514	3.03+ per cent.
State, 1855,	1,132,369	2.63 per cent.
United States, 1860,	1,231,066	1.68+ per cent.
State, 1865,	1,267,031	.58 per cent.
United States, 1870,	1,457,351	2.84 per cent.
State, 1875,	1,651,912	2.54 per cent.
United States, 1880,	1,783,085	1.54 per cent.
State, 1885,	1,942,141	1.72+ per cent.
United States, 1890,	2,238,943	2.88+ per cent.
State, 1895,	2,500,183	2.23+ per cent.

Mean annual rate of increase for the whole period, 1765-1895, 1.82 per cent., or, more accurately, 1.8199+.

TABLE 2. — *Population by Sexes, Massachusetts.*

Census Years.	Total.	Males.	Females.	Per Cent. M.	Per Cent. F.	Females to 1,000 Males.	Sex not Stated.
1765, . .	238,195	105,042	109,747	48.90	51.10	1,045	23,406
1776, . .	295,080	-	-	-	-	-	-
1790, . .	378,787	182,742	190,582	48.95	51.05	1,043	5,463
1800, . .	422,845	205,135	211,258	49.38	50.62	1,029	6,452
1810, . .	472,040	229,742	235,561	49.38	50.62	1,025	6,737
1820, . .	523,287	255,462	267,697	48.83	51.17	1,048	128
1830, . .	610,408	297,826	312,188	48.82	51.18	1,048	394
1840, . .	737,700	365,333	372,367	49.52	50.48	1,019	-
1850, . .	994,514	488,517	505,997	49.12	50.88	1,036	-
1855, . .	1,132,369	550,034	582,335	48.57	51.43	1,059	-
1860, . .	1,231,066	596,713	634,353	48.47	51.53	1,063	-
1865, . .	1,267,031	602,010	665,021	47.51	52.49	1,105	-
1870, . .	1,457,351	703,779	753,572	48.29	51.71	1,071	-
1875, . .	1,651,912	794,383	857,529	48.09	51.91	1,079	-
1880, . .	1,783,085	858,440	924,645	48.14	51.86	1,077	-
1885, . .	1,942,141	932,884	1,009,257	48.03	51.97	1,082	-
1890, . .	2,238,943	1,087,709	1,151,234	48.58	51.42	1,058	-
1895, . .	2,500,183	1,214,701	1,285,482	48.58	51.42	1,058	-

NOTE. — The figures for each of the census enumerations prior to but not including 1820 present the numbers of the sexes for white persons only, the sex of colored persons being omitted in the published returns. In the returns for 1765 there appears to have been a considerable number, in addition to the colored population, who were not classified by sex. The total population at the census of 1765 does not include 1,569 non-taxable Indians, and that of 1776 does not include 4,761 colored persons.

TABLE 3. — *Massachusetts — Population by Age Periods. — State and National Census (1855-95).*

Years.	Under 5.	5-9 Inclusive.	10-14 Inclusive.	15-19 Inclusive.	20-29 Inclusive.	30-39 Inclusive.	40-49 Inclusive.	50-59 Inclusive.	60-69 Inclusive.	70-79 Inclusive.	80 and Over.	Unknown.
1855,	132,944	115,862	110,098	117,047	235,678	165,046	111,500	71,829	42,423	20,810	6,791	2,341
1860,	151,289	128,526	114,348	120,800	244,519	183,705	125,470	81,453	49,873	23,536	7,536	1
1865,	133,943	143,391	126,691	117,171	225,506	185,543	142,831	96,446	59,216	26,675	8,316	1,302
1870,	156,889	139,796	148,371	142,184	274,859	214,151	162,689	108,348	68,401	31,895	9,727	41
1875,	173,855	163,738	148,365	165,936	310,861	240,966	182,823	126,430	79,186	38,283	11,167	10,302
1880,	179,307	171,595	161,425	167,595	343,701	264,413	203,515	142,053	91,619	44,337	13,525	-
1885,	178,338	181,842	176,551	187,247	384,750	287,219	222,920	156,760	101,619	49,235	15,516	144
1890,	203,758	195,578	192,228	214,613	465,387	341,622	253,181	178,131	114,172	55,886	17,886	6,501
1895,	235,647	224,119	202,900	225,881	521,392	400,134	282,781	199,511	125,283	61,011	18,510	3,014
	171,775	162,716	153,442	162,053	334,073	253,644	187,523	128,996	81,310	39,074	12,109	2,627

Percentages.

Years.	Under 5.	5-9 Inclusive.	10-14 Inclusive.	15-19 Inclusive.	20-29 Inclusive.	30-39 Inclusive.	40-49 Inclusive.	50-59 Inclusive.	60-69 Inclusive.	70-79 Inclusive.	80 and Over.	Unknown.
1855,	11.74	10.23	9.72	10.34	20.81	14.58	9.86	6.34	3.74	1.84	.60	.21
1860,	12.29	10.44	9.29	9.81	19.86	14.92	10.19	6.62	4.05	1.91	.62	-
1865,	10.57	11.32	9.99	9.25	17.80	14.64	11.27	7.61	4.67	2.11	.66	.10
1870,	10.77	9.59	10.18	9.76	18.86	14.70	11.16	7.43	4.69	2.19	.67	-
1875,	10.58	9.91	8.98	10.04	18.82	14.69	11.07	7.65	4.79	2.82	.68	.62
1880,	10.06	9.62	9.05	9.40	19.28	14.83	11.41	7.97	5.14	2.49	.76	-
1885,	9.18	9.86	9.09	9.64	19.81	14.79	11.48	8.07	5.23	2.54	.80	.01
1890,	9.10	8.73	8.59	9.59	20.78	15.26	11.31	7.95	5.10	2.50	.80	.29
1895,	9.43	8.96	8.12	9.03	20.86	16.00	11.31	7.98	5.01	2.44	.74	.12
	10.17	9.63	9.08	9.59	19.78	15.01	11.10	7.64	4.81	2.31	.72	.16

Ages. — In Table 3 are presented the numbers of the population at different age periods for each of the census years from 1855 to 1895, together with the percentages of the total population. These figures show that the relative numbers of the population at ages under 20 have diminished during these forty years, those of the age period 20–30 have remained nearly stationary, while those of the later ages have increased.

The deficiencies of the census at ages under five years have received sufficient comment in the twenty-sixth annual report of the Board, pages liii–lvii.

Population by Nativity and by Races.

Under the term "nativity" it has been the custom in most statistical documents to group the component parts of the population into two classes, one of which comprises the population born in the United States and the other embraces the sum of the persons of different nationalities born outside the United States. The term, however, so far as statistics are concerned, must be regarded very largely as one of degree, since nearly the entire population is descended from foreign ancestry of greater or less remoteness of degree. No census enumeration has attempted to gather information dating back more than two generations at the farthest.

The following table presents the numbers and percentages of the native and foreign populations at different census periods: —

TABLE 4. — *Population by Nativity in Census Years (Massachusetts).*

Year.	Population.		Percentage.	
	Native.	Foreign.	Native.	Foreign.
1850,	830,490	164,024	83.51	16.49
1855,	886,575	245,263	78.33	21.67
1860,	970,960	260,106	78.88	21.12
1865,	999,976	265,486	79.02	20.98
1870,	1,104,032	353,319	75.76	24.24
1875,	1,225,829	418,904	74.53	25.47
1880,	1,339,594	443,491	75.13	24.87
1885,	1,415,274	526,867	72.88	27.12
1890,	1,581,806	657,137	70.65	29.35
1895,	1,735,253	764,930	69.41	30.59

NOTE. — In each of the census enumerations of 1855, 1865 and 1875 a small number of persons whose nativity was unknown (in no case more than 1 per cent.) is excluded from the table.

From the foregoing table it appears that the foreign population has increased from a percentage of 16.49 in 1850, to 30.59 in 1895, the greatest relative increase having taken place between 1850 and 1855.

Race. — The following table presents the population classified as white and colored, the latter term embracing negroes, mulattoes, Chinese, Japanese and Indians: —

TABLE 5. — *Population, White and Colored (Massachusetts).*

YEARS.	POPULATION.		PERCENTAGES.	
	White.	Colored.	White.	Colored.
1850, ...	985,450	9,064	99.09	.91
1855, ...	1,122,463	9,906	99.13	.87
1860, ...	1,221,432	9,602	99.22	.78
1865, ...	1,256,864	10,167	99.20	.80
1870, ...	1,443,156	13,947	99.04	.96
1875, ...	1,635,620	16,292	99.02	.98
1880, ...	1,763,782	18,697	98.95	1.05
1885, ...	1,922,944	19,197	99.01	.99
1890, ...	2,215,373	22,144	99.01	.99
1895, ...	2,471,418	28,765	98.85	1.15

In the following table are presented the vital statistics of the State for the whole period of registration, including the estimated population for intercensal years and the rates per 1,000 living: —

TABLE 6. — *Marriages, Births and Deaths in Massachusetts (1842-95), with Population and Rates per 1,000 Living.*

YEARS.	Population.	Marriages.	Births.	Deaths.	Excess of Births over Deaths.	Persons Married to 1,000.	Births to 1,000 Persons.	Deaths to 1,000 Persons.	Excess Rate of Births over Deaths.
*1841-42, ...	783,116	5,742	8,571	9,544	-	-	-	-	-
*1842-43, ...	806,862	5,807	8,750	10,684	-	-	-	-	-
*1843-44, ...	831,828	4,304	14,757	8,338	-	-	-	-	-
*1844-45, ...	856,536	4,863	15,711	8,844	-	-	-	-	-
*1845-46, ...	882,508	5,263	16,486	12,114	-	-	-	-	-
*1846-47, ...	909,267	5,390	17,097	14,492	-	-	-	-	-
*1847 48, ...	936,838	5,287	16,515	15,609	-	-	-	17.17	-
†1848, ...	-	4,015	12,540	12,475	-	-	-	19.58	-
‡1849, ...	965,245	6,936	25,773	20,423	5,350	-	26.70	21.16	5.54
1850, ...	994,514	10,345	27,664	16,606	11,058	20.80	27.82	16.70	11.12
1851, ...	1,020,678	11,966	28,681	18,984	9,747	23.44	28.10	18.55	9.55
1852, ...	1,047,520	11,578	29,802	18,482	11,320	22.10	28.45	17.64	10.81
1853, ...	1,075,072	12,828	30,920	20,301	10,619	23.86	28.76	18.88	9.88
1854, ...	1,103,350	13,683	31,997	21,414	10,583	24.80	29.00	19.41	9.59
1855, ...	1,132,369	12,329	32,845	20,798	12,047	21.77	29.01	18.37	10.64

* The statistics of the first eight years of registration are for the years ending with April 30 of each year.
† The second line of statistics for 1848 is for the eight months ending Dec. 31, 1848.
‡ The statistics for 1849 and for each of the following years are for the calendar years ending Dec. 31.

TABLE 6 — *Concluded.*

Years.	Population.	Marriages.	Births.	Deaths.	Excess of Births over Deaths.	Persons Married to 1,000.	Births to 1,000 Persons.	Deaths to 1,000 Persons.	Excess Rate of Births over Deaths.
1856, ...	1,151,461	12,265	34,445	20,734	13,711	21.30	29.91	18.00	11.91
1857, ...	1,170,864	11,739	35,320	21,280	14,040	20.05	30.16	18.17	11.99
1858, ...	1,190,584	10,527	34,491	20,776	13,715	17.68	28.97	17.45	11.52
1859, ...	1,210,657	11,475	35,422	20,976	14,446	18.96	29.26	17.33	11.93
1860, ...	1,231,066	12,404	36,051	23,068	12,983	20.15	29.28	18.74	10.54
1861, ...	1,238,177	10,972	35,445	24,085	11,360	17.72	28.63	19.45	9.17
1862, ...	1,245,328	11,014	32,275	22,974	9,301	17.69	25.92	18.45	7.47
1863, ...	1,252,521	10,873	30,314	27,751	2,563	17.36	24.20	22.15	2.05
1864, ...	1,259,756	12,513	30,449	28,753	1,696	19.87	24.17	22.83	1.35
1865, ...	1,267,031	13,051	30,249	26,152	4,097	20.60	23.87	20.64	3.23
1866, ...	1,302,992	14,428	34,085	23,637	10,448	22.14	26.16	18.14	8.02
1867, ...	1,339,976	14,451	35,062	22,772	12,290	21.57	26.17	17.00	9.17
1868, ...	1,378,010	13,856	36,193	25,603	10,590	20.12	26.26	18.58	7.68
1869, ...	1,417,125	14,826	36,141	26,054	10,087	20.92	25.50	18.39	7.12
1870, ...	1,457,351	14,721	38,259	27,329	10,930	20.20	26.25	18.75	7.50
1871, ...	1,494,334	15,746	39,791	27,943	11,848	21.08	26.63	18.70	7.93
1872, ...	1,532,258	16,142	43,235	35,019	8,216	21.08	28.22	22.85	5.37
1873, ...	1,571,146	16,437	44,481	33,912	10,569	20.92	28.31	21.58	6.73
1874, ...	1,611,022	15,564	45,631	31,887	13,744	19.32	28.32	19.79	8.53
1875, ...	1,651,912	13,663	43,996	34,978	9,018	16.54	26.63	21.17	5.46
1876, ...	1,677,351	12,749	42,149	33,186	8,963	15.20	25.13	19.78	5.34
1877, ...	1,703,182	12,758	41,850	31,342	10,508	14.98	24.57	18.40	6.17
1878, ...	1,729,410	12,893	41,238	31,303	9,935	14.91	23.84	18.10	5.74
1879, ...	1,756,042	13,802	40,295	31,801	8,494	15.72	22.94	18.11	4.83
1880, ...	1,783,085	15,538	44,217	35,292	8,925	17.42	24.80	19.79	5.01
1881, ...	1,813,818	16,768	45,220	36,458	8,762	18.49	24.93	20.10	4.83
1882, ...	1,845,081	17,684	45,670	36,785	8,885	19.17	24.75	19.93	4.82
1883, ...	1,876,883	18,194	47,285	37,748	9,537	19.38	25.19	20.11	5.08
1884, ...	1,909,233	17,333	48,615	36,990	11,625	18.16	25.46	19.38	6.08
1885, ...	1,942,141	17,052	48,790	38,094	10,696	17.56	25.12	19.61	5.51
1886, ...	1,998,174	18,018	50,788	37,244	13,544	18.04	25.41	18.64	6.77
1887, ...	2,055,823	19,533	53,174	40,763	12,411	19.00	25.87	19.85	6.04
1888, ...	2,115,136	19,739	54,893	42,097	12,796	18.66	25.95	19.90	6.05
1889, ...	2,176,159	20,397	57,075	41,777	15,298	18.74	26.23	19.20	7.03
1890, ...	2,238,943	20,838	57,777	43,528	14,249	18.62	25.81	19.44	6.37
1891, ...	2,288,911	21,675	63,004	45,185	17,819	18.94	27.53	19.74	7.79
1892, ...	2,339,993	22,507	65,824	48,762	17,062	19.24	28.13	20.84	7.29
1893, ...	2,392,216	22,814	67,192	49,084	18,108	19.07	28.09	20.52	7.57
1894, ...	2,445,604	20,619	66,936	46,791	20,145	16.86	27.37	19.14	8.24
1895, ...	2,500,183	23,102	67,545	47,540	20,005	18.48	27.02	19.01	8.01

All estimates of intercensal years are made in accordance with the rule recommended by Dr. Farr (the geometric rate of increase).

The vital statistics of the first seven years of registration (1842–48), together with the returns or marriages for 1849, must be regarded as extremely defective; many of the returns from Suffolk County for this period are wanting, together with those of some of the small towns. From the year 1849 onward the omissions probably constitute but a small percentage only of the total registration.

The figures for the population of census years are given in bold type.

INTERSTATE AND INTERNATIONAL VITAL STATISTICS.

The following table presents the marriage, birth and death rates of the New England States and the principal civilized countries of the world for 1893, 1894 and 1895:—

TABLE 7.—*Summary of the Vital Statistics of Principal Countries for 1893, 1894 and 1895, together with those of the New England States.*

STATES AND COUNTRIES.	1893.				1894.				1895.			
	Marriage-rate.	Birth-rate.	Death-rate.	Excess of Birth-rate over Death-rate.	Marriage-rate.	Birth-rate.	Death-rate.	Excess of Birth-rate over Death-rate.	Marriage-rate.	Birth-rate.	Death-rate.	Excess of Birth-rate over Death-rate.
Massachusetts,	18.7	27.5	20.1	7.4	16.9	27.4	19.1	8.3	18.5	27.0	19.0	8.0
Maine,	17.4	20.9	16.7	4.2	16.8	20.9	16.5	4.4	-	-	-	-
New Hampshire,	21.2	20.5*	19.9	-	20.0	20.2*	17.8	-	20.5	21.1*	17.7	-
Vermont,	17.7	20.5	16.1	4.4	17.0	20.5	15.6	4.9	13.6	21.2	16.5	4.7
Rhode Island,	19.0	25.8	20.0	5.8	17.1	25.1	18.7	6.4	18.2	25.7	19.6	6.1
Connecticut,	16.4	24.7	18.9	5.8	14.2	24.9	16.8	8.1	16.2	23.4	17.8	5.6
ALL NEW ENGLAND,	18.5	25.3	19.4	5.9	17.1	24.7	18.1	6.6	17.7†	25.1†	18.4†	6.7†
England and Wales,	14.7	30.8	19.2	11.6	15.1	29.6	16.6	13.0	15.0	30.4	18.7	11.7
Scotland,	13.2	31.0	19.4	11.6	13.4	30.1	17.2	12.9	13.7	30.4	19.7	10.7
Ireland,	9.4	23.0	17.9	5.1	9.4	22.9	18.2	4.7	10.1	23.2	18.4	4.8
Italy,	14.7	36.6	25.3	11.3	15.0	35.7	25.1	10.6	14.7	35.1	25.2	9.9
Denmark,	14.1	30.6	18.9	11.7	13.9	30.2	17.5	12.7	14.2	30.2	16.9	13.3
Norway,	12.8	30.7	16.4	14.3	12.8	29.7	16.9	12.8	12.9	30.5	15.6	14.9
Sweden,	11.3	27.4	16.8	10.6	11.5	27.1	16.4	10.7	-	-	-	-
Austria,	15.9	37.9	27.2	10.7	15.8	36.7	27.8	8.9	16.2	38.6	27.6	11.0
Hungary,	18.6	42.5	31.1	11.4	18.4	41.3	30.4	10.9	16.8	41.5	29.6	11.9
Switzerland,	14.7	28.5	20.5	8.0	14.9	28.2	20.7	7.5	15.0	28.0	19.7	8.3
German Empire,	15.8	36.7	24.6	12.1	15.9	35.8	22.3	13.5	15.9	36.1	22.2	13.9
Holland,	14.6	33.8	19.2	14.6	14.4	32.7	18.5	14.2	14.7	32.8	18.6	14.2
Belgium,	15.2	29.5	20.3	9.2	15.1	29.0	18.6	10.4	15.5	28.5	19.5	9.0
France,	15.0	22.9	22.8	0.1	15.0	22.4	21.2	1.2	14.3	21.9	22.3	—0.4‡
Japan,	17.3	28.0	22.2	5.8	16.8	28.5	20.0	8.5	-	-	-	-

* Registration of births said to be defective. † Except Maine. ‡ Excess of death-rate.

MARRIAGES.

The whole number of marriages registered in Massachusetts in 1895 was 23,102, and the marriage-rate per 1,000 of the living population was 9.24. The number of persons married in each 1,000 of the population was 18.48, as compared with a rate of 16.86 in 1894 and 19.07 in 1893. Comparing the two twenty-year periods 1856–75 and 1876–95, the marriage-rates were 19.77 for the former period and 17.94 for the latter, so that there has been a decrease of 1.83 per 1,000, comparing the two periods.

The successive five-year periods show considerable fluctuations and are as follows, beginning with the period 1856–60: 19.62, 18.66, 20.96, 19.73, 15.66, 18.54, 18.62 and 18.50.

The following table presents the number of marriages with the marriage-rates for each year, each five-year, ten-year and each twenty-year period. The numbers for earlier years may be found in the table on page 721.

TABLE 8.— *Marriages and Marriage-rates, Massachusetts, 1856-95.*

Years.	Marriages.	Marriage-rates.			Years.	Marriages.	Marriage-rates.		
		Persons Married per 1,000.	Five-year Periods.	Ten-year Periods.			Persons Married per 1,000.	Five-year Periods.	Ten-year Periods.
1856,	12,265	21.30			1876,	12,749	15.20		
1857,	11,739	20.05			1877,	12,758	14.98		
1858,	10,527	17.68	19.62		1878,	12,893	14.91	15.66	
1859,	11,475	18.96			1879,	13,802	15.72		
1860,	12,404	20.15		19.13	1880,	15,538	17.42		17.16
1861,	10,972	17.72			1881,	16,768	18.49		
1862,	11,014	17.69			1882,	17,684	19.17		
1863,	10,878	17.36	18.66		1883,	18,194	19.38	18.54	
1864,	12,513	19.87			1884,	17,333	18.16		
1865,	13,051	20.60			1885,	17,062	17.56		
1866,	14,428	22.14			1886,	18,018	18.04		
1867,	14,451	21.57			1887,	19,533	19.00		
1868,	13,856	20.12	20.96		1888,	19,739	18.66	18.62	
1869,	14,826	20.92			1889,	20,397	18.74		
1870,	14,721	20.20		20.31	1890,	20,838	18.62		18.56
1871,	15,746	21.08			1891,	21,675	18.94		
1872,	16,142	21.08			1892,	22,507	19.24		
1873,	16,437	20.92	19.73		1893,	22,814	19.07	18.50	
1874,	15,564	19.32			1894,	20,619	16.86		
1875,	13,663	16.54			1895,	23,102	18.48		
Mean of twenty-year periods,				19.77,					17.94

Mean of forty years = 18.67.

The maximum marriage-rate in any year of the forty-year period was 22.14 per 1,000 in 1866, and the minimum was 14.91 in 1878.

The marriage-rate of England has declined slightly, from a maximum of 17.9 in 1853 to a minimum of 14.2 in 1886, and then slightly increased to 15.6 in 1891. Those of Denmark, Sweden and Hungary have declined slightly, while those of Prussia, Italy and France have remained nearly stationary.

A more correct measure of the marriage-rate is the relation of the number of marriages to the number of unmarried persons of marriageable age of each sex. For this purpose the figures of the State Census of 1885 are selected, and it is assumed that males are marriageable at the age of sixteen and females at the age of fifteen. A very small number of females were married at ages under fifteen, but the number was less than one-tenth of one per cent. of the total number of females who were married in that year. The term "marriageable population" embraces all single persons, divorced, and widowers and widows of the ages named.

The following figures present the ratio of the married persons to the marriageable persons of the same year: —

TABLE 9. — *Relation of Marriages to Marriageable Population in Massachusetts, 1885.*

Marriageable Persons.		Persons Married of Each Sex.	Rate per 1,000 of Marriageable Population.	
Males.	Females.		Males.	Females.
277,180	370,973	17,052	61.5	46.0

Marriages to Each 1,000 Marriageable Persons of Each Sex in Different Countries.

Countries.	Males.	Females.	Countries.	Males.	Females.
Bavaria, ...	57	44	England, ...	62	53
Würtemberg, . . .	64	45	Sweden, ...	53	37
Austria, ...	58	50	Switzerland, . . .	50	39
Italy, ...	49	49	Massachusetts, . .	61.5	46
France, ...	57	46			

The foregoing figures comprise the statistics of about eight million marriages in the countries named, and require the following interpretation: The term "marriageable persons" in the figures for Austria, Italy and England relates to such unmarried persons of each sex as are fifteen years of age and over. In the figures for Switzerland it relates to men eighteen years old and over and women sixteen years old and over.

Ages. — The following table presents the average age at marriage of all men and women married, and of all men and women married for the first time, for the five years 1891–95: —

TABLE 10. — *Mean Age at Marriage, 1891–95, in Massachusetts, expressed in Years and Fractions of a Year.**

YEARS.	Average Age of All Bridegrooms.	Average Age of All Brides.	Average Age of Men Marrying the First Time.	Average Age of Women Marrying the First Time.
1891,	28.85	25.53	26.82	24.28
1892,	28.85	25.37	26.78	24.24
1893,	28.90	25.47	26.86	24.40
1894,	29.10	25.59	26.93	24.39
1895,	28.91	25.59	26.86	24.42

* For earlier years see forty ninth registration report, 1890.

The figures for England differ but little from those of Massachusetts, and show a tendency toward increasing age at marriage for both sexes.

TABLE 11. — *Mean Age at Marriage, in England, 1885–95.*

YEARS.	All Men.	All Women.	Bachelors.	Spinsters.
1885,	28.15	25.86	26.08	24.58
1890,	28.32	26.03	26.38	24.81
1895,	28.42	26.16	26.59	25.04

For the two twenty-year periods, 1856–75 and 1876–95, the mean ages of males and females at marriage were as follows: —

TABLE 12. — *Mean Age at Marriage, Massachusetts, 1856–95.*

Men.

TWENTY-YEAR PERIODS.	Whole Number of Persons whose Ages were known at Time of Marriage.	Total Years of Life lived at Date of Marriage.	Mean Age at Marriage in Years and Fractions of a Year.
1856–75,	261,882	7,640,653	28.85
1876–95,	363,723	10,548,543	29.00

Women.

TWENTY-YEAR PERIODS.	Whole Number of Persons whose Ages were known at Time of Marriage.	Total Years of Life lived at Date of Marriage.	Mean Age at Marriage in Years and Fractions of a Year.
1856–75,	264,258	6,585,332	24.92
1876–95,	363,553	9,236,727	25.41

By the foregoing table it appears that the mean age of men at marriage has increased from 28.85 to 29 years, or fifteen hundredths of a year, or about one month and twenty-five days, comparing the first period of twenty years with the latter period. The mean age of women has increased during the same time forty-nine hundredths of a year, or about five months and twenty-eight days.

Nativity. — The nativity of persons married in Massachusetts during 1895 was as follows, in percentages of the total number married whose nativity was known: Native born, 55.63; foreign born, 44.37.

Three couples whose nativity was unknown are not included in the foregoing figures.

For the whole period of forty years, divided into two twenty-year periods, the statistics were as follows: —

TABLE 13. — *Marriages by Nativity for the State, 1856–95.*

Period.	Couples.	American.	Foreign.	American Male.	Foreign Male.	Unknown.	Percentages.	
							American.	Foreign.
1856-75, .	266,667	152,435	79,810	14,397	17,286	2,709	63.75	36.25
1876-95, .	364,013	185,922	104,447	38,956	34,537	151	61.20	38.80

From the foregoing table it appears that the whole number of native-born persons married in the first twenty-year period was 336,553, or 63.75 per cent., and those of foreign birth were 191,263, or 36.25 per cent.

In the second period the persons of native birth were 445,337, or 61.20 per cent., and those of foreign birth were 38.80 per cent. In this table those of unknown birth are excluded in calculating the percentages.

The foregoing figures convey no information as to the marriage-rates of persons of native and of foreign birth. This information can only be gained by a comparison of these groups of the population with the marriages or persons married in each.

The following table presents the population at census years, with the number of persons married and the marriage-rates of each group: —

TABLE 14. — *Marriages and Marriage-rates by Nativity, Massachusetts (1850–95).*

YEAR.	POPULATION.		PERSONS MARRIED.		MARRIAGE-RATES.	
	Native.	Foreign.	Native.	Foreign.	Native.	Foreign.
1850, . .	830,490	164,024	13,486	5,798	16.24	35.35
1855, . .	886,575	245,263	14,790	9,492	16.68	38.70
1860, . .	970,960	260,106	15,363	8,911	15.82	34.26
1865, . .	999,976	265,486	16,942	9,036	16.94	34.04
1870, . .	1,104,032	353,319	18,795	10,617	17.02	30.05
1875, . .	1,225,829	418,904	17,752	9,572	14.48	22.85
1880, . .	1,339,594	443,491	21,499	9,571	16.05	21.58
1885, . .	1,415,274	526,867	21,593	12,499	15.26	23.72
1890, . .	1,581,806	657,137	23,866	17,780	15.09	27.06
1895, . .	1,735,253	764,930	25,701	20,497	14.81	26.80

From the foregoing table it would appear at first sight that the marriage-rate of the foreign population is very much in excess of that of the native population, the excess ranging in different census years from 34 to 132 per cent.

There are, however, certain reasons for this excessive difference which exists in the age constitution of these two groups of the population. In the native population the age distribution approaches quite nearly that of a normally constituted population, like that of Sweden, while that of the foreign population is influenced by the age of the immigrants entering the State. Of the immigrants who entered the United States at several successive census periods, more than one-half were between the ages of fifteen and thirty years and more than two-thirds were between the ages of fifteen and forty. (See note, page iv, twenty-sixth report of State Board of Health, 1894.) Furthermore, while the population of foreign birth constituted 27.1 per cent. of the total population by the census of 1885, the foreign population under fifteen years of age was only 7.3 per cent. of the total population of those ages, and the foreign population between the ages of fifteen and sixty constituted 34.6 per cent. of the total population of those ages, as shown by the following table : —

TABLE 15. — *Percentage of Native and Foreign Population at Certain Ages, 1885, in Massachusetts.*

AGE PERIODS.	Native.	Foreign.	
All under fifteen years,	92.7	7.3	100.0
Fifteen to sixty years,	65.4	34.6	100.0
All over sixty,	70.6	29.4	100.0

Since the period fifteen to sixty embraces nine-tenths of all persons of marriageable ages, it follows that, other things being equal, the class having relatively the greatest number of persons at these ages would show the greater marriage-rate. This, however, can account for only a fraction of the excess.

Races. — The only registration reports of Massachusetts in which the vital statistics of different races are given are those of 1888 and 1889.

The following table presents the number of persons married and marriage-rates of those years, both of the white and of the colored population: —

TABLE 16. — *Persons Married, 1888 and 1889, White and Colored, and Marriage-rates.*

YEARS.	ESTIMATED POPULATION.		PERSONS MARRIED.		MARRIAGE-RATES (PERSONS MARRIED).	
	White.	Colored.	White.	Colored.	White.	Colored.
1888,	2,094,220	20,916	38,969	509	18.4	24.4
1889,	2,154,637	21,522	40,309	485	18.7	22.5

In the foregoing statement the term "colored" embraces negroes, mulattoes, Chinese, Japanese and Indians. The Chinese, Japanese and Indians have at no time within the forty-year period under consideration constituted more than 5 per cent. of those enumerated as colored persons.

Marriages by Months. — For the two twenty-year periods, 1856-75 and 1876–95, the figures were as follows: —

TABLE 17. — ***Marriages by Months, 1856-95, with Relative Figures for Other Countries.***

MONTHS.	MARRIAGES.		MONTHLY RATIO REDUCED TO A STANDARD OF 100.							
					1876-80.					
	1856-75.	1876-95.	1856-75.*	1876-95.*	Switzerland.	German Empire.	Austria.	Italy.	France.	Sweden.
January,	24,518	29,950	108.7	97.0	71	92	98	121	119	41
February,	18,714	[illegible]	[illegible]	92.4	128	122	284	107	[illegible]	58
March,	14,107	16,966	62.5	[illegible]	82	66	21	84	82	96
April,	21,262	30,418	97.8	101.8	115	[illegible]	40	105	100	109
May,	23,170	27,823	102.7	89.5	137	123	[illegible]	89	104	98
June,	22,752	37,723	104.1	125.2	96	93	94	76	114	108
July,	[illegible]	25,274	[illegible]	82.1	85	84	72	68	94	76
August,	18,265	24,740	[illegible]	80.1	77	67	61	[illegible]	71	81
September,	22,617	33,460	104.5	112.0	90	85	74	96	86	67
October,	25,704	30,958	114.3	129.4	116	135	114	100	116	122
November,	32,117	44,173	151.6	147.6	134	156	249	126	126	170
December,	[illegible]	27,504	[illegible]	[illegible]	76	77	7	110	93	126
Total,	265,028	363,898	–	–	–	–	–	–	–	–
Mean,	–	–	100.0	100.0	100	100	100	100	100	100
Daily mean for whole period,	–	–	36.4	49.8	–	–	–	–	–	–

* In each of the eight columns of relative figures the inaccuracies due to the unequal length of the months are eliminated. The figures in the last six columns are the result of observations upon over five million marriages in the countries named.

From the foregoing table it appears that during the forty years 1856–95 considerable changes have taken place in the times and seasons selected for marriage, when the two twenty-year periods are compared. Using the number 100 as a standard of comparison in each instance, there appears to have been a decrease in January in the intensity of the marriage-rate, from 8.7 per cent. above the mean to 3 per cent. below it. In April, there was an increase from 2.2 below the mean to 1.8 per cent. above it. In May, there was a decrease from 2.7 above to 10.5 per cent. below the mean.

The greatest divergence from the mean appears in March and November, that of March having increased from 37.5 below the mean

to 45.1 per cent. below, and that of November having decreased from 51.6 above the mean to 47.8 above. Religious and social customs undoubtedly account largely for these differences in the marriage-rate in different months as well as for the differences between the conditions prevailing in the two twenty-year periods.

The months of June and October have increased considerably in popular favor as months for marriage, as also appears by consulting the following figures for the single year 1895.

For the single year 1895 the monthly ratios (upon a standard of 100) were as follows: First six months in their order, 87.4, 96.4, 43.8, 97.5, 74.4, 151.5; second six months, 84.0, 80.6, 120.7, 141.2, 144.7, 81.0.

The mean daily number for the year was 63.3.

The mean daily number of marriages had increased from 36.4 per day in the first twenty-year period to 49.8 in the second, while the mean daily numbers in the extreme years 1856 and 1895 were 33.5 and 63.3.

Fecundity of Marriage.

The marriages in any year give rise to births which are recorded during the following twenty years or nearly so. The division of the sum of these births by the marriages would express the fecundity of the marriages, but it is impossible to follow each family and count the children, hence some ready method must be adopted for estimating the fecundity. In a stationary population in which the marriages do not increase from year to year, the births of any year might be divided by the marriages of the same year to obtain the desired result, but the marriages are constantly increasing, hence the births of a given year must be divided by the marriages of a previous year. Since the ages of mothers are not a matter of record, the interval in Massachusetts which intervenes between the mean age of marriage and the mean age of mothers when their children are born is unknown.

This interval in Sweden is six years, and Dr. Farr assumes a similar period for England. In the twenty-eighth registration report of Michigan (1894), Dr. Wilbur assumes a mean period of five years, and states that "for convenience, comparison of births may well be made with the marriages of the preceding five-year period, and with little sacrifice of accuracy." The mean period for the foreign born is slightly longer than that for the native born.

Assuming a five-year period for Massachusetts, the fecundity for all marriages is as follows: —

For those which occurred in the period 1851–55 = 2.8 children per marriage.
For those which occurred in the period 1856–60 = 2.7 children per marriage.
For those which occurred in the period 1861–65 = 3.1 children per marriage.
For those which occurred in the period 1866–70 = 3.0 children per marriage.
For those which occurred in the period 1871–75 = 2.7 children per marriage.
For those which occurred in the period 1876–80 = 3.5 children per marriage.
For those which occurred in the period 1881–85 = 3.1 children per marriage.
For those which occurred in the period 1886-90 = 3.4 children per marriage.

These figures do not exactly express the fertility of all *child-bearing women*, since a small ratio of illegitimate children are included in the living births whose mothers are not represented in the marriages. The difference in the result in Massachusetts would, however, be very slight, affecting the figures, mostly, only in the second place of decimals.

The fecundity of the native and of the foreign born differs very greatly, as is shown by the following table, which presents the ratio of births in each census year, as compared with the marriages at a census five years earlier: —

TABLE 18. — *Fecundity of the Marriages in Census Years.*

Years.	Children Born to Each Marriage.	
	Native.	Foreign.
1850,	2.5	5.0
1855,	2.4	3.7
1860,	1.9	3.5
1865,	2.1	4.5
1870,	2.2	4.4
1875,	2.4	4.4
1880,	2.2	5.0
1885,	2.4	5.0
1890,	2.4	4.3

This method is not quite so accurate as the comparison of groups of years, but the approximate mean of the two columns, 2.3 for native marriages and 4.4 for those of the foreign born, shows that the number of children in the latter class is nearly twice that of the former.

A population with only 2.3 children to each married couple is not holding its own, after allowing for the deaths which occur in the first five years of life.

BIRTHS.

The whole number of living births registered in 1895 was 67,545. This number was larger than that of any previous year. It exceeded the births of the previous year by 609, and those of 1893 by 353. It was also greater than those of 1885 by 18,755. It exceeded those of 1875 by 23,549, and was considerably more than double the number which occurred in 1865.

The number of births in each 1,000 of the living population in 1895 was 27.02. This birth-rate was less than that of either of the four immediately preceding years but greater than that of any other year since 1874.

Comparing the birth-rates of the two twenty-year periods, 1856–75 and 1876–95, the birth-rates were 27.11 per 1,000 for the former period and 25.86 for the latter, — the difference being 1.25 per 1,000 in favor of the former.

The birth-rates of successive five-year periods, beginning with 1856–60, were as follows: 29.51, 25.34, 26.07, 27.62, 24.25, 25.09, 25.86 and 27.62.

The following table presents the numbers of living births and the birth-rates for each year, together with the birth-rates of five-year, ten-year and twenty-year periods. The numbers for earlier years may be found in the table on page 721.

TABLE 19.— *Births and Birth-rates, Massachusetts, 1856-95.*

Years.	Births.	Birth-rates: Birth-rates per 10,000 Living.	Birth-rates: Five-year Period.	Birth-rates: Ten-year Period.	Years.	Births.	Birth-rates: Birth-rates per 10,000 Living.	Birth-rates: Five-year Period.	Birth-rates: Ten-year Period.
1856,	34,445	29.91			1876,	42,149	25.13		
1857,	35,320	30.16			1877,	41,850	24.57		
1858,	34,491	28.97	29.51		1878,	41,238	23.84	24.25	
1859,	35,422	29.26			1879,	40,295	22.94		
1860,	36,051	29.28		27.38	1880,	44,217	24.80		24.69
1861,	35,445	28.63			1881,	45,220	24.93		
1862,	32,275	25.92			1882,	45,670	24.75		
1863,	30,314	24.20	25.34		1883,	47,285	25.19	25.09	
1864,	30,449	24.17			1884,	48,615	25.46		
1865,	30,249	23.87			1885,	48,790	25.12		
1866,	34,085	26.16			1886,	50,788	25.41		
1867,	35,062	26.17			1887,	53,174	25.87		
1868,	36,193	26.26	26.07		1888,	54,893	25.96	25.86	
1869,	36,141	25.50			1889,	57,075	26.23		
1870,	38,259	26.25		26.89	1890,	57,777	25.81		26.79
1871,	39,791	26.63			1891,	63,004	27.53		
1872,	43,235	28.22			1892,	65,824	28.13		
1873,	44,481	28.31	27.62		1893,	67,192	28.09	27.62	
1874,	45,631	28.32			1894,	66,936	27.37		
1875,	43,996	26.63			1895,	67,546	27.02		
Total,	731,335	-			Total,	1,049,537	-		
Mean (20 years),	-	27.11			Mean (20 years),	-	25.86		

Mean of 40 years, 26.36

Sex.—Of the whole number of living children born in 1895, 34,623 were males and 32,905 were females, indicating a ratio of 1,052 males to 1,000 females.

The following were the numbers by sexes for the five years 1891–95:—

TABLE 20.— *Births by Sexes, 1891-95.*

Years.	Males.	Females.	Males to 1,000 Females.
1891,	32,532	30,434	1,069
1892,	33,758	31,951	1,057
1893,	34,328	32,829	1,046
1894,	34,338	32,575	1,054
1895,	34,623	32,905	1,052

For the two twenty-year periods 1856–75 and 1876–95 the totals and means were as follows:—

TABLE 21.—*Births by Sexes, 1856-95.*

PERIODS.	Males.	Females.	Males to 1,000 Females.
1856-75, ...	375,324	354,466	1,059
1876-95, ...	515,185	489,468	1,053

The births whereof the sex was unknown are excluded from the foregoing summary. They constituted less than one-fifth of one per cent. of the whole number.

The ratio of males to females for all actual conceptions would be slightly higher than those presented above, since the ratio of males to females among the still-born is usually much higher than that of living births. For example, for the year 1895 the ratio of males to females among all births, living and dead, was 1,066 instead of 1,052, as expressed in the table. The ratio for the whole period of forty years was also 1,066 males to 1,000 females for all births, living and dead.

Other Countries.

The following figures show the relation of the sexes at birth in different countries for a ten-year period (1871-80): —

TABLE 22.—*Births of Males to 1,000 Females.*

German Empire,*	1,062	Holland, ...	1,063
Switzerland, ...	1,063	England,†	1,038
Austria, ...	1,067	Denmark, ...	1,058
Italy, ...	1,071	Sweden, ...	1,060
France, ...	1,063	Norway, ...	1,061
Belgium, ...	1,058	*Massachusetts*,‡	1,066

* The figures for the German Empire are for the years 1872-80.

† Still-births not included in the figures for England, which probably accounts for its difference from the other figures.

‡ The statistics for Massachusetts are for the forty years 1856-95.

The foregoing figures are the average results of over 50,000,000 births which occurred in the countries named.

Seasons.—The number of births in each month during the two periods 1856-75 and 1876-95, together with the daily number of births in each month and the monthly ratio reduced to a standard of 100, is

shown in the following table, wherein it appears that the greatest daily number occurred in August in each period and the least in January in the first period and in May in the second.

For the single year 1895 the monthly ratios upon a standard of 100 were as follows: First six months, 101.2, 101.7, 94.8, 90.7, 95.3, 98.5; second six months, 103.3, 104.9, 105.3, 102.7, 98.4, 102.9.

The mean daily number for the year was 185.04.

TABLE 23. — *Births by Months, 1856-95.*

Months.	Births.		1856-75.			1876-95.		
	1856-75.	1876-95.	Monthly Ratio Reduced to a Standard of 100.	Quarterly Ratio.	Half-yearly Ratio.	Monthly Ratio Reduced to a Standard of 100.	Quarterly Ratio.	Half-yearly Ratio.
January, . .	55,398	85,151	89.3			95.6		
February, .	52,477	80,019	92.9	92.9		98.6	97.4	
March, . .	59,897	87,328	96.6			98.0		
April, . .	55,640	81,773	92.7		93.5	94.9		96.5
May, . .	57,633	83,719	93.0	94.1		94.0	95.6	
June, . .	58,000	84,594	96.7			98.1		
July, . .	63,476	92,724	102.4			104.1		
August, . .	67,181	94,987	108.3	106.3		106.6	105.0	
September, .	64,936	90,030	108.2			104.4		
October, . .	66,169	90,203	106.7		106.4	101.3		103.4
November, .	63,614	87,481	106.0	106.6		101.5	101.8	
December, .	66,334	91,441	107.0			102.7		
Totals, . .	730,705	1,049,450	-	-	-	-	-	-
Means, . .	-	-	100.0	100.0	100.0	100.0	100.0	100.0
Daily number,	100.03	143.7	-	-	-	-	-	-

The mean daily number of births in the first period, 1856–75, was 100.03 and that of the second period was 143.7.

Comparing the two extreme years, 1856 and 1895, the mean daily number had nearly doubled, the figures being 94.1 per day in 1856 and 185.04 in 1895.

The relative excess of births in the last half of the year over the first half had diminished in the following ratio: —

For each 1,000 births in the first half of the year there were 1,138 births in the last half for the twenty years 1856–75, and for the twenty years 1876 to 1895 there were 1,000 births in the first half to 1,071 births in the last half (in equal periods of time).

Births by Parent Nativity. — Since the gross numbers of births of the native and the foreign population of the State, with the percentages of each to the total number of births, convey no correct idea of the birth-rates of these groups of the population, they are omitted in the following table, and the births of the native and foreign population are compared in each instance with the living population of each group as found by census enumeration.

In the following table the births of mixed parentage are equally distributed between those of native and those of foreign birth; the numbers of children having native mothers and foreign fathers and those of children having foreign mothers and native fathers are nearly equal. A small percentage of births of unknown parentage is excluded from the table.

TABLE 24. — *Births and Birth-rates by Parent Nativity, Massachusetts.*

YEARS.	POPULATION.		BIRTHS.		BIRTH-RATES.	
	Native.	Foreign.	Native Parentage.	Foreign Parentage.	Native.	Foreign.
1850, . . .	830,490	164,024	16,189	8,197	19.49	49.98
1855, . . .	886,575	245,263	16,755	14,516	18.90	59.20
1860, . . .	970,960	260,106	17,877	17,343	18.41	66.68
1865, . . .	999,976	265,486	14,479	15,333	14.48	57.76
1870, . . .	1,104,032	353,319	17,584	20,360	15.93	57.62
1875, . . .	1,225,829	418,904	20,228	23,203	16.50	55.40
1880, . . .	1,339,594	443,491	21,722	21,243	16.22	47.90
1885, . . .	1,415,274	526,867	23,258	24,169	16.43	45.87
1890, . . .	1,581,806	657,137	26,084	31,422	16.49	47.82
1895, . . .	1,735,253	764,930	28,774	38,551	16.58	50.40

These enormous differences in the birth-rate of the native and the foreign population must be considered in connection with two or more limiting facts. First, the age constitution of the foreign population is quite different from that of the native population, since, as was shown under the section relating to marriages (page 728), the former contains a greater ratio of persons of child-bearing ages. Second, the race constitution of the native and foreign populations is quite different, the latter being composed very largely of persons from countries where the birth-rate is high. The continuous immigration of French Canadians of adult, child-bearing ages has had an undoubted effect upon the birth-rate.

The population enumerated in the different censuses as being of British-American birth had increased from 21,707 in 1855 to 147,352 in 1885, and of the latter, 64,503 were French Canadians.*

Plural Births. — In 1895 the number of cases of plural birth was 745, of which 736 were cases of twin births and 9 were cases of triplets, the whole number of children born in such plural births being 1,499, of which 773 were males and 726 were females.

This was equivalent to the following ratios: 1.09 per cent. for cases of twins, or 1 case to 92 living births, and .013 per cent. for cases of triplets, or 1 case to each 7,505 living births.

For the two twenty-year periods the figures were as follows: —

TABLE 25. — *Plural Births, 1856–95.*

PERIODS.	All Births.	Cases of Twins.	Cases of Triplets.	Percentage of Twin Births.	Percentage of Triplet Births.	Living Births to One Case of Twins.	Living Births to One Case of Triplets.
1856-75, . .	731,335	6,852	76	0.94	.013	106.7	9,623
1876-95, . .	1,049,537	9,450	109	0.90	.013	111.1	9,629

The foregoing figures are derived from more than one and three-fourths million births which occurred in Massachusetts in the forty years 1856–95. They may be compared with the statistics of about twenty million births which occurred in the following countries, mostly during the ten years 1874–83: —

TABLE 26. — *Ratio of Plural Births.*

	Twins in 1,000 Labors.	Triplets in 1,000 Labors.
Switzerland,†	12.2	0.12
Prussia,†	12.2	0.13
Bavaria,†	12.4	0.15
Austria,†	11.7	0.15
Italy,†	12.1	0.15
France,†	9.8	0.11
Sweden,†	14.4	0.17
Massachusetts, 1856-95, ...	9.2	0.13

* See Report of Provincial Board of Health of Quebec, 1895-96, page 58, for birth-rates in counties inhabited mostly by the French population.

† Die Bewegung der Bevölkerung. Bern, 1885.

Still-births. — The whole number of still-births registered in the two twenty-year periods, together with the number of living births whose sex was known, is indicated in the following table: —

ABLE 27. — *Living Births and Still-births, 1856–95.*

Periods.	Males.				Females.				Mean Per Cent. both Sexes.
	Living.	Still-born.	Total.	Per Cent. Still-born.	Living.	Still-born.	Total.	Per Cent. Still-born.	
1856-75, . . .	375,324	11,391	386,715	2.95	354,466	7,589	362,055	2.10	2.54
1876-95, . . .	515,185	20,265	535,450	3.78	489,468	18,613	508,081	2.71	3.26
Totals, . . .	890,509	31,656	922,165	-	843,934	21,202	865,136	-	-
Means, . . .	-	-	-	3.42	-	-	-	2.45	2.96

The deaths of males to those of females, among the still-born infants whose sex was known, in the first period, maintained the ratio of 1,501 males to 1,000 females, and in the second period 1,489 males to 1,000 females.

The recorded fatality for each sex was greater in the second period than it was in the first, being for males 2.95 per cent. of all recorded births of males living or dead, in the first period, and 3.78 in the second, and for females 2.10 per cent. in the first and 3.26 in the second.

The mean percentage of the whole period for males was 3.42 and for females 2.45, and for both sexes 2.96, the latter being the ratio of 52,858 still-births to 1,787,301 births living and dead, of those whose sex was known.

In the first period there were 1,589 still-births the sex of which was not registered, or 7.7 per cent. of the whole number of still-births registered in that period. In the second period there were 1,558 of this class, or 4.6 of the whole number. This reduction, not only in the relative but also in the absolute figures, may be taken as an indication of more perfect registration, and probably furnishes a partial explanation of the increased percentage of the still-born in the second period as compared with the first.

The still-births registered in 1895 were 2,367, of which number 1,423 were males, 892 were females, and the sex of 52 was not stated.

The following figures comprise the statistics of over a half-million still-births which were registered in the countries named : —

TABLE 28. — *Still-births in 100 Births.**

	Males.	Females.	Totals.		Males.	Females.	Totals.
German Empire, .	4.28	3.52	3.91	Belgium, . .	4.28	3.34	3.82
Austria, . .	2.77	2.27	2.53	Sweden, . .	3.23	2.56	2.91
Italy, . . .	3.33	2.69	3.02	Switzerland, .	4.27	3.43	3.87

* Die Bewegung der Bevölkerung in der Schweiz. Bern.

The death-rate of the still-born among illegitimates is usually from 10 to 30 per cent. higher than that of legitimate infants.

Illegitimacy.

The record of illegitimacy in Massachusetts must be more or less incomplete, because under existing laws there is no requirement that the certificate shall contain the facts as to legitimacy or illegitimacy. A partial clue to the solution of this question exists in the names of the parents, which must be recorded. The tendency of legislation in this direction does not appear to improve the accuracy of the record. Moreover, a considerable number of births occurs in each year in which the parentage is unknown, or not stated in the record. The presumption is that most of these births are illegitimate.

With these facts in view the following figures are presented, for the period 1856–91.

During the first twenty years of the period, from 10 to 25 per cent. of the recorded illegitimate births occurred in the three State almshouses at Tewksbury, Bridgewater and Monson. To these should be added, in the second period, a small number at the Reformatory Prison for Women. The relative number of such births at public institutions was less in the second period than in the first. The unusual ratio recorded in Suffolk County is due to a larger number of such births in the public charitable and correctional institutions of Boston.

TABLE 29. — *Illegitimate Births in Massachusetts, 1856-91.*

Years.	Illegitimate Births.	Ratio to 1,000 Births.	Years.	Illegitimate Births.	Ratio to 1,000 Births.
1856, . . .	257	7.5	1876, . . .	713	16.9
1857, . . .	242	6.9	1877, . . .	697	16.6
1858, . . .	293	8.5	1878, . . .	640	15.5
1859, . . .	237	6.7	1879, . . .	716	17.8
1860, . . .	294	8.2	1880, . . .	778	17.6
1861, . . .	290	8.2	1881, . . .	801	17.7
1862, . . .	247	7.6	1882, . . .	865	18.9
1863, . . .	277	9.1	1883, . . .	899	19.0
1864, . . .	285	9.3	1884, . . .	894	18.4
1865, . . .	271	8.9	1885, . . .	903	18.5
1866, . . .	281	8.2	1886, . . .	1,034	20.3
1867, . . .	292	8.3	1887, . . .	1,158	21.8
1868, . . .	366	10.1	1888, . . .	1,058	19.3
1869, . . .	286	7.9	1889, . . .	1,045	18.3
1870, . . .	285	7.4	1890, . . .	1,206	20.9
1871, . . .	432	10.9	1891, . . .	1,078	17.1
1872, . . .	303	7.0	1892, . . .	-	-
1873, . . .	587	13.2	1893, . . .	-	-
1874, . . .	648	14.2	1894, . . .	-	-
1875, . . .	632	14.4	1895, . . .	-	-
	6,805	9.3		14,485	18.5

If any reliance can be placed in these figures, illegitimacy has increased considerably in Massachusetts, comparing the two periods, that of the first being as 9.3 per 1,000 births and that of the second period as 18.5 per 1,000.

On account of the defective character of the returns upon this point for the years 1892, 1893, 1894 and 1895, the figures of these years are omitted from the foregoing table, and the total number of illegitimate births at the bottom of the column (14,485) and the ratio (18.5) are for the sixteen years ending with 1891.

Sex. — In the twenty years 1856–75 there were registered 3,294 births of illegitimate males and 3,472 of females, or in the ratio of 1,054 females to 1,000 males. The sex of 39 was unknown.

In the twenty years 1876–95 there were registered 8,820 births of illegitimate males and 8,302 of females, and the sex of 33 was unknown, or in the ratio of 941 females to 1,000 males.

The following table presents the illegitimate birth-rates deduced from over thirty million births in the countries named: —

TABLE 30. — *Illegitimacy in Different Countries.**

	Illegitimate Births per 1,000 Births.		Illegitimate Births per 1,000 Births.
The German Empire,	88	England,	48
Austria,	140	Denmark,	102
Italy,	73	Sweden,	101
France,	74	Norway,	85
Belgium,	75	Switzerland,	50
Holland,	32	*Massachusetts* (1856-91),	13

* Die Bewegung der Bevölkerung in der Schweiz. Bern.

DEATHS.

The number of deaths registered in 1895 was 47,450. This was greater than the number registered in 1894 by 659, but was less than those of 1892 or 1893. The death-rate per 1,000 of the living population was 19.01, which was less than that of any previous year since 1879, except that of 1886, which was 18.64 per 1,000.

Comparing the death-rates of the two twenty-year periods, 1856–75 and 1876–95, the death-rates were nearly identical, or 19.49 for the former and 19.51 per 1,000 for the latter period, the difference being only .02.

The death-rates of the successive five-year periods were as follows: 17.94, 20.71, 18.19, 20.83, 18.84, 19.82, 19.41 and 19.83.

The following table presents the deaths and death-rates for each year from 1856 to 1895 inclusive, together with the death-rates for the five-year, ten-year and twenty-year periods. The numbers for earlier years may be found in the table on page 721.

TABLE 31. — *Deaths and Death-rates, 1856-95, Massachusetts.*

YEARS.	Deaths.	DEATH-RATES.			YEARS.	Deaths.	DEATH-RATES.		
			Five-year Periods.	Ten-year Periods.				Five-year Periods.	Ten-year Periods.
1856, . . .	20,734	18.00			1876, . .	33,186	19.78		
1857, . . .	21,280	18.17			1877, . .	31,342	18.40		
1858, . . .	20,776	17.45	17.94		1878, . .	31,303	18.10	18.84	
1859, . . .	20,976	17.33			1879, . .	31,801	18.11		
1860, . . .	23,068	18.74		19.36	1880, . .	35,292	19.79		19.35
1861, . . .	24,085	19.45			1881, . .	36,458	20.10		
1862, . . .	22,974	18.45			1882, . .	36,785	19.93		
1863, . . .	27,751	22.15	20.71		1883, . .	37,748	20.11	19.82	
1864, . . .	28,753	22.83			1884, . .	36,990	19.38		
1865, . . .	26,152	20.64			1885, . .	38,094	19.61		
1866, . . .	23,637	18.14			1886, . .	37,244	18.64		
1867, . . .	22,772	17.00			1887, . .	40,763	19.85		
1868, . . .	25,603	18.58	18.19		1888, . .	42,097	19.90	19.41	
1869, . . .	26,054	18.39			1889, . .	41,777	19.20		
1870, . . .	27,329	18.75		19.59	1890, . .	43,528	19.44		19.63
1871, . . .	27,943	18.70			1891, . .	45,185	19.74		
1872, . . .	35,019	22.85			1892, . .	48,762	20.84		
1873, . . .	33,912	21.58	20.83		1893, . .	49,084	20.52	19.83	
1874, . . .	31,887	19.79			1894, . .	46,791	19.14		
1875, . . .	34,978	21.17			1895, . .	47,540	19.01		
Total, . .	525,683	-			Total, . .	791,770	-		
Mean, . .	-	19.49			Mean, . .	-	19.51		
Mean of 40 years, ...							19.50 per 1,000		

The course of the death-rate from year to year is shown in the foregoing table and in the diagram on page 712. In the table the year 1872 is shown to have had an unusually high death-rate, a fact which appears upon inspection to have been due to the prevalence of several infectious diseases as epidemics.

In that year small-pox caused a death-rate of 6.7 per 10,000, which was more than four times greater than the mean death-rate of the twenty-year period from this cause, and was also much the highest of the whole period of forty years. The death-rate from measles was also nearly double the mean of the twenty-year period, and greater than that of any year of the forty-year period except one. The death-rate from scarlet-fever was a little greater than the mean of the twenty years. That of typhoid fever was greater than that of any year except two in the forty years. That of cholera infantum was double the mean of the twenty-year period, and the greatest of any year in the entire forty years. That of pneumonia was also greater than the death-rate of any year of the twenty-year period except one.

Such a year was also 1849, in a still earlier period, when the death-rate, even with more imperfect registration, amounted to 21.16 per 1,000.

In that year diarrhœal diseases (including 1,188 registered as from Asiatic cholera) produced a death-rate of 46.0 per 10,000 living, and amounted to 21.7 per cent. of the total mortality, as compared with a mean of less than 10 per cent. in the forty years 1856–95. Dysentery in that year attained the enormous death-rate of 25.4 per 10,000 living, a mortality far beyond that of any year in the whole period of registration from this cause. The deaths registered as from dysentery in that year were more than the entire number registered from the same cause in the previous seven years of registration.

Deaths by Sexes. — The number of registered deaths of males in 1895 was 24,175, and that of females was 23,365.

The death-rate of males was 19.91 and that of females was 18.18 per 1,000 of the living population of each sex.

The following table presents the mortality of the sexes during the census years 1860–95: —

TABLE 32. — *Mortality of the Sexes in Census Years, 1860-95.*

YEARS.	Deaths of Males.	Deaths of Females.	Death-rate of Males.	Death-rate of Females.	Deaths of Males to 1,000 Deaths of Females in Equal Numbers Living.
1860, ...	11,444	11,547	19.3	18.4	1,048
1865, ...	13,085	13,024	21.7	19.6	1,107
1870, ...	13,699	13,598	19.5	18.6	1,048
1875, ...	17,329	17,619	21.8	20.5	1,063
1880, ...	17,426	17,852	20.3	19.3	1,052
1885, ...	18,889	19,205	20.2	19.0	1,063
1890, ...	21,767	21,761	20.0	18.9	1,058
1895, ...	24,175	23,365	19.9	18.2	1,095

The disparity between the death-rates of the sexes in Massachusetts was generally less than that of England, which was as 1,121 deaths of males to 1,000 deaths of females in equal numbers living for 1894, and as 1,103 to 1,000 for the whole period of registration, 1838–94.

Deaths by Seasons. — In the following table are presented the statistics of deaths by months and by sexes in Massachusetts for the year 1895: —

TABLE 33.—*Mortality by Months, Massachusetts, 1895.*

MONTHS.	1 Males.	2 Females.	3 Totals.	4 Death-rate per 1,000.	5 Monthly Mortality Reduced to a Standard of 100.*	6 Deaths per Day.
January, ...	1,926	1,904	3,830	18.13	94.8	123.5
February, ...	2,260	2,284	4,544	23.82	124.6	162.3
March, ...	2,321	2,331	4,652	22.03	115.2	150.1
April, ...	1,959	1,949	3,908	19.02	100.0	130.3
May, ...	1,899	1,752	3,651	17.20	90.4	117.8
June, ...	1,602	1,519	3,121	15.18	79.8	104.0
July, ...	2,055	1,862	3,917	18.36	97.0	126.4
August, ...	2,457	2,314	4,771	22.35	118.2	153.9
September, ...	2,094	2,024	4,118	19.94	105.4	137.3
October, ...	1,931	1,892	3,823	17.81	94.7	123.3
November, ...	1,801	1,691	3,492	16.82	89.4	116.4
December, ...	1,870	1,843	3,713	17.31	92.0	119.8
	24,175	23,365	47,540	19.01	100.0	130.25

* In column 5 100 is taken as the annual mean for a monthly period of uniform length.

In the foregoing table, in the figures presented in columns 5 and 6 the inaccuracies due to the unequal length of the months have been eliminated by comparing the daily number of deaths in each month with the mean daily number for the year. It is also quite plain that an estimate of population which may be applied in calculating the death-rate in January and February cannot reasonably be applied to the same purpose in November and December, since the annual increase of the population, amounting in recent years to about 60,000 annually, is thus disregarded. Hence, in estimating the death-rates given in column 4, a quarterly estimate has been adopted based upon the rate of growth from 1890 to 1895, after the method adopted by the Registrar General of England in his weekly reports. By this table it appears that the highest daily number of deaths occurred in February, and the next highest in August and in March, and the least daily number occurred in June, November and May.

The percentages of deaths in each quarter of the year were as follows:—

In the first quarter, ...	27.40
In the second quarter, ...	22.47
In the third quarter, ...	26.94
In the fourth quarter, ...	23.19
	100.00

Deaths by Months for Two Twenty-year Periods. — In the following table are presented the deaths by months for the two twenty-year periods 1856–75 and 1876–95: —

TABLE 34. — *Deaths by Months, 1856–95, with Relative Figures for Other Countries.*

MONTHS.	DEATHS.		DAILY AVERAGE FOR EACH MONTH, QUARTER AND HALF YEAR COMPARED WITH THE DAILY MEAN FOR THE YEAR.						OTHER COUNTRIES, 1876–80.*				
	1856–75.	1876–95.	1856–75.			1876–95.			Switzerland.	German Empire.	Austria.	Italy.	France.
January,	41,331	70,539	92.7			105.0			110.7	102.1	111.0	109.1	107.7
February,	38,628	61,238	96.6	95.8		103.8	102.5		116.9	107.3	126.1	106.3	112.7
March,	43,557	68,750	97.7		92.4	102.3		97.8	114.6	106.4	118.0	104.5	107.3
April,	41,065	66,355	95.2			102.1			113.1	107.2	114.1	94.1	105.6
May,	40,431	63,105	90.7	89.4		93.9	93.2		105.4	104.4	103.4	84.1	99.1
June,	35,530	54,920	82.4			83.5			96.1	96.9	87.6	85.3	92.7
July,	48,217	73,476	103.7			109.3			90.8	94.2	85.1	108.9	92.4
August,	59,234	80,666	132.8	119.7		120.0	111.4		93.7	99.0	88.2	111.5	90.8
September,	52,893	67,963	122.6		107.5	104.5		102.2	89.5	96.1	85.9	106.1	95.0
October,	44,506	62,580	99.9			93.1			82.3	90.9	89.3	97.3	96.7
November,	38,541	57,043	91.7	95.3		88.8	92.8		89.4	93.6	96.8	97.2	93.9
December,	41,865	64,919	94.2			96.6			98.8	100.6	104.6	100.7	100.3
Total,	525,118	791,754	-		-	-		-	-	-	-	-	-
Mean,	71.9	108.4	100.0			100.0			100.0	100.0	100.0	100.0	100.0

* The figures for other countries are the result of observations upon over seventeen million deaths registered in the countries named.

By the foregoing table it appears that in the first twenty-year period the mean daily number of deaths was 71.9 and in the second period 108.4. The months in which the deaths were above the mean were July, August and September in the first period, and January, February, March, April, July, August and September in the second period. In the first period the deaths in the first half of the years compared with those in the last half were as 1,000 to 1,163, and in the second period as 1,000 to 1,045 (in equal periods of time).

Nativity. — Since no statement of deaths by nativity appears in the registration reports until 1888, the deaths and death-rates of the native and foreign population are only presented for the years 1888–95.

The populations of each group are also given, with estimates for the intercensal years.

TABLE 35. — *Population, Deaths and Death-rates, Native and Foreign, for the Years 1888-95.*

Years.	Population.			Deaths.		Death-rates.	
	Native.	Foreign.	Total.	Native.	Foreign.	Native.	Foreign.
1888, .	1,513,273	601,863	2,115,136	31,124	10,574	20.6	17.6
1889, .	1,547,214	628,945	2,176,159	30,650	10,687	19.8	17.0
1890, .	1,581,806	657,137	2,238,943	31,605	11,508	20.0	17.5
1891, .	1,611,437	677,474	2,288,911	32,733	11,907	20.3	17.6
1892, .	1,641,590	698,403	2,339,993	35,097	13,044	21.4	18.7
1893, .	1,672,271	719,945	2,392,216	35,285	13,136	21.1	18.3
1894, .	1,703,490	742,114	2,445,604	34,301	11,895	20.1	16.0
1895, .	1,735,253	764,930	2,500,183	34,472	12,515	19.9	16.4
				265,267	95,266	20.4	17.4

The foregoing table shows that the death-rate of the foreign population for the eight years was less in each year than that of the native population, the mean difference for the whole period 1888–95 being 3 in each 1,000 living.

This difference may be partly accounted for by the difference in the age constitution of these two groups of the population, as was stated under the section relating to marriages. The same difference which would produce an increased marriage and birth rate would also produce a diminished death-rate, other things being equal.

Density of Population.

It was shown in the early reports of the Registrar-General of England that the death-rate of communities bears a definite relation to the density of population. The area of a state or county remaining constant, as the population increases the density increases. The proximity of persons to each other and their consequent liability to communicate infectious diseases increase with the density.

In the following table the population of the State is divided into two groups of counties, which may be properly called urban and rural groups. The former contains 56 cities and towns, each having a population of more than 5,000 (census of 1895); the latter has 29 such places.

Nearly nine-tenths of the inhabitants of the former group live in these populous cities and towns, while the population of the latter group living in such places is less than half of the population of the group.

TABLE 36. — *Relation of the Death-rate to Density of Population, by Groups of Counties, 1895.*

	Counties.	Area in Sq. Miles.	Persons to Sq. Mile.	Population. 1895.	Deaths. 1895.	Death-rates per 1,000. 1895.
Urban.	Suffolk,	48	11,246	539,799	12,114	22.4
	Essex,	525	629	330,393	6,213	18.9
	Middlesex,	858	581	499,217	8,982	18.0
	Bristol,	587	373	219,019	4,266	19.5
	Norfolk,	535	252	134,819	2,165	16.1
	Hampden,	635	240	152,938	2,941	19.2
		3,188	588	1,876,185	36,681	19.6
Rural.	Worcester,	1,596	192	306,445	5,491	17.9
	Plymouth,	698	145	101,498	1,696	16.7
	Hampshire,	597	91	54,710	913	16.7
	Berkshire,	958	90	86,292	1,386	16.1
	Barnstable,	417	66	27,654	592	21.4
	Nantucket,	53	57	3,016	76	25.2
	Franklin,	698	57	40,145	608	15.2
	Dukes,	110	39	4,238	97	22.9
		5,127	122	623,998	10,859	17.4
	The State,	8,315	301	2,500,183	47,540	19.0

In the accompanying table the density is expressed by the average number of persons living upon each square mile of area. The same might also be expressed in terms of acres to each person, as in the twenty-third annual report (paper on "Geographical Distribution of Disease").

The density has increased as follows: —

TABLE 37. — *Density of Population, 1860-95.*

Years.	Urban Districts.		Rural Districts.		Difference.
	Persons to Sq. Mile.	Death-rate.	Persons to Sq. Mile.	Death-rate.	
1860,	262	19.6	77	16.8	2.8
1870,	319	19.5	86	17.0	2.5
1880,	405	20.5	96	18.0	2.5
1890,	520	20.0	118	17.8	2.2
1895,	588	19.6	122	17.4	2.2

NOTE. — In the supplement to the twenty-fifth annual report of the Registrar-General of England, Dr. Farr gives a definite statement of the relation which subsists between the density of population and the death-rate, which is briefly as follows, as determined by observation, dividing the population into five groups: —

"1. Where the death-rate was 14, 15 or 16 per 1,000 the density of the population averaged 86 persons per square mile.

"2. Where the death-rate was 17, 18 or 19 per 1,000 the population was 172 per square mile.

"3. Where the death-rate was 20, 21 or 22 per 1,000 the population was 255 per square mile.

"4. Where the death-rate was 23, 24 or 25 per 1,000 the population was 1,128 per square mile.

"5. Where the death-rate was 26 and upwards the density of the population averaged 3,399 persons per square mile."

In 1855 Massachusetts held a position as regards density about midway between the first and second of the foregoing groups (the density then being 136 per square mile), while in 1895 it had advanced to a position between the third and fourth groups (with a density of 300 per square mile). Yet during these four decades the death-rate remained practically the same, — 19.4, 19.6, 19.4, 19.6, — a fact that may be taken to show that improved sanitary conditions have very nearly counterbalanced the unfavorable influence of increasing density.

Deaths by Ages.

The mortality at different ages constitutes an important index of the sanitary condition of a community and hence requires careful consideration.

"As tests of the sanitary condition, the death-rates of infants under one year and of children under five years of age are more important than the rates at any other groups of ages. Investigation has shown beyond doubt that the ages of young children are very incorrectly returned at the census enumeration, owing to the general and indiscriminate use of two methods for describing age. At the census enumerations the numbers of infants under one year of age are understated." (Memorial volume on "Vital Statistics," London, 1885, page 114.)

The foregoing comment by Dr. Farr applies with equal justice to each of the enumerations of the United States census and to those of Massachusetts. (See report of the Board for 1894, page liv.)

Hence, in the following table the infantile death-rate is not calculated upon the census figures for living children under one year but upon the registered births, in accordance with the method advised by Dr. Chalmers in his "New Life-table of Glasgow," page 14.

No attempt has been made to carry this estimate beyond the fifth year of life, since the disturbing effect of migration seriously affects the accuracy of any calculation upon this basis when applied to a rapidly increasing New England community. The newly arrived foreign-born infants in the first year of life constitute less than 1 per cent. of the children of that age, and the foreign-born children among those under five years of age constitute less than 4 per cent. of all children of that age; but the foreign born among the population from thirty to fifty years of age constitute fully 40 per cent. of the population of those ages. It is chiefly for this reason that the construction of an accurate life-table from the population and mortality tables of an American State is rendered practically impossible.

TABLE 38.—*Infant Mortality, Massachusetts, 1856-95, Forty Years.*

YEARS.	Births in Year ending June 30.	Deaths under One.	Death-rate under One per 1,000 Births.	YEARS.	Births in Year ending June 30.	Deaths under One.	Death-rate under One per 1,000 Births.
1856, .	33,593	4,226	125.8	1876, .	43,340	6,700	154.6
1857, .	34,919	4,160	119.2	1877, .	41,635	6,343	152.4
1858, .	35,210	4,197	119.2	1878, .	41,622	6,189	148.7
1859, .	34,425	4,175	121.3	1879, .	41,010	5,855	142.8
1860, .	36,180	4,821	133.2	1880, .	42,420	7,190	169.5
1861, .	35,570	5,167	145.2	1881, .	44,715	7,389	165.2
1862, .	34,064	4,216	124.0	1882, .	45,280	7,445	164.4
1863, .	31,276	4,545	145.2	1883, .	45,993	7,515	163.3
1864, .	30,004	4,693	156.4	1884, .	48,666	7,735	158.9
1865, .	30,481	4,869	159.6	1885, .	48,710	7,625	156.5
1866, .	31,295	4,699	150.1	1886, .	49,214	7,848	159.5
1867, .	34,792	4,763	136.9	1887, .	52,364	8,514	162.6
1868, .	35,775	5,421	151.5	1888, .	53,770	8,870	164.9
1869, .	35,684	5,368	150.5	1889, .	56,140	9,105	162.2
1870, .	37,753	6,206	164.4	1890, .	57,823	9,625	166.5
1871, .	38,770	5,996	154.7	1891, .	60,246	10,186	169.0
1872, .	41,393	8,390	202.7	1892, .	63,969	10,649	166.5
1873, .	43,563	7,911	181.6	1893, .	66,492	10,990	165.3
1874, .	45,570	7,489	164.3	1894, .	67,574	10,899	161.3
1875, .	44,828	7,712	172.0	1895, .	66,746	10,564	158.2
Total, .	725,145	109,024	-	Total, .	1,037,729	167,236	-
Mean, .	-	-	150.3	Mean, .	-	-	161.2

Mean of whole period, 156.7.

Strictly speaking, the death-rate of infants under one year is obtained by comparing the deaths of such infants occurring in a year with the mean number of infants under one living throughout a year, and this number must "lie between the annual number of births and that number diminished by the deaths under one. It would be nearer the latter than the former number on account of the excess of deaths in the first months of life." (Dr. Farr.)

For the sake of uniformity in comparison with the statistics of other states and countries, the deaths under one are here compared with the births. In the foregoing table the births in the first line (1856) are those which occurred between July 1, 1855, and June 30, 1856, inclusive, and so on through the table, the births in the last line being for the year ending June 30, 1895.

The deaths under one in the same table are those of the calendar years ending Dec. 31, 1856, 1857, etc. The births in this whole period were 1,762,874, and the deaths under one year were 276,260, which is equivalent to a death-rate of 156.7 per 1,000 living births, as a mean of the whole period.

Dividing the whole time into ten and twenty year periods, the infantile death-rate of the first twenty years was 150.3 and that of the second twenty years was 161.2 per 1,000 births. The difference in the rates of the ten-year periods is much greater, chiefly on account of the disturbing effect of the epidemic years 1872 and 1873, when cholera infantum prevailed to an unusual degree. The infantile death-rates of the four ten-year periods were, respectively, 134.2, 164.2, 157.8, 163.6. By this it appears that the infantile death-rate has increased considerably when we compare the first twenty years with the last twenty, and especially when the first and last ten years are compared. If the figures for the two years 1872 and 1873 were to be omitted from the table, the infantile death-rate of the remaining eight years in the ten-year period 1866–75 would be reduced to 156.5.

The death-rate of infants under one has diminished with considerable uniformity during the last five years (1891–95) from 169.0 per 1,000 births in 1891 to 158.2 in 1895.

Infant Mortality of Cities.

For the purpose of presenting the infant mortality of the cities of Massachusetts, a ten-year period has been selected, and since only eleven out of the thirty-two cities embraced in this summary existed as incorporated cities at the beginning of the period under consideration, the ten years 1881–90 are selected for examination. The later ten-year period 1886–95 would have been selected, but unfortunately the presentation of the deaths by ages in the different cities in the State appears to have been abandoned in the registration reports since 1890.

In the following table the cities are arranged with reference to their comparative rank so far as infant mortality is concerned.

Of the first seven cities in this table all except Boston are cities in which the cotton and woollen industries largely predominate. In the first three the tenement-house population is also unusually large.

In the twenty-third report of the Board, page 836, attention was also called to the fact that the mortality from cholera infantum, which is one of the chief factors of the death-rate under one year, bears a direct relation to the ratio of married women employed away from their homes, and this ratio reaches its maximum in Fall River, where this class constitutes 3.1 per cent. of the total population.

There are also several smaller towns, not included in this list (Webster, Ware, Adams and Millbury), in which the same class of manufactures is conducted, and which have a considerable tenement-house population, with a high rate of infant mortality.

The cities of Haverhill, Marlborough, Brockton and Lynn, each having an infantile death-rate below that of the State at large, are all shoe manufacturing towns, in which the tenement-house population is comparatively small.

Near the bottom of the list are the cities of Malden, Everett, Medford and Newton, in which the residential population largely predominates. The manufacturing population constitutes but a small fraction, and the infantile death-rate is much less than that of the State.

The death-rate of infants for the State at large was 160 per 1,000 births, while that of the combined urban population was 175 per 1,000 and that of the rural population was 129.

TABLE 89.—*Infant Mortality of Cities, Ten Years, 1881-90.*

	Births.	Deaths, 0-1.	Infantile Mortality.*	Rank, the State = 100.
Fall River,	18,557	4,449	239.7	149
Lowell,	18,684	4,158	222.5	139
Lawrence,	11,724	2,508	213.9	133
Boston,	117,574	22,134	188.2	117
Salem,	6,998	1,264	180.6	112
New Bedford,	9,642	1,713	177.7	111
Chicopee,	3,583	631	176.1	110
Cambridge,	17,262	2,974	172.3	107
Holyoke,	11,730	1,972	168.1	105
Chelsea,	6,446	1,076	166.9	104
Springfield,	10,276	1,616	157.3	98
Haverhill,	5,748	903	157.1	98
Worcester,	21,211	3,300	155.6	97
Marlborough,	3,363	520	154.6	96
Somerville,	7,894	1,211	154.3	96
Newburyport,	3,137	479	152.7	95
Brockton,	4,902	720	146.9	91
Pittsfield,	3,563	516	144.8	90
Lynn,	11,856	1,668	140.7	88
Taunton,	6,571	923	140.5	87
Gloucester,	5,726	795	138.8	86
Northampton,	3,021	410	135.7	84
Fitchburg,	4,804	645	134.3	84
Malden,	4,745	633	133.4	83
Everett,	1,956	258	131.9	82
Waltham,	3,660	482	131.7	82
Medford,	2,025	265	130.9	81
Woburn,	3,771	479	127.0	79
Quincy,	4,242	526	124.0	77
Beverly,	1,817	216	118.9	74
North Adams,	5,310	611	115.1	72
Newton,	4,370	489	111.9	70
Urban,	346,168	60,544	174.9	109
Rural,	163,119	21,127	129.5	80
THE STATE,	509,287	81,671	160.4	100

* Deaths of infants under one year per 1,000 births.

Passing on to the next years of childhood, and employing the method advised by Dr. Chalmers for the whole period of forty years, the death-rates are as follow: —

TABLE 40.—*Death-rate per 1,000 Living at Same Ages.*

Ages.	Periods.	
	1856-75.	1876-95.
1-2 years,	67.9	54.3
2-3 years,	36.0	28.4
3-4 years,	24.5	20.5
4-5 years,	18.8	15.6

From these figures it appears that certain interesting changes have taken place in the mortality of children in Massachusetts during the forty years under consideration. The death-rate of infants under one year is greater now than it was in the first half of the period, but the death-rate of children from one to five years is less than it was then.

The probability that an infant under one year old will complete its first year of life is less at the present day than it was in the first half of the period, but, having survived his first year of life, his chance of completing the next four years is considerably greater than it then was. A discussion of some of the conditions contributing to these changes will be found on a later page, under the title "The Balance of Mortality."

The infantile death-rate differs much in different countries, since in some communities it amounts to as much as one-third of the births and in others it is not more than one-tenth.

The following table presents the infantile death-rate, as stated by Dr. Eross in a recent paper in Koch's "Zeitschrift f. Hygiene" (Vol. 19, 1896, page 371):—

TABLE 41.—*Infant Mortality, Deaths under One per 1,000 Births.*

Countries.	Years.	Infant Mortality per 1,000 Births.	Countries.	Years.	Infant Mortality per 1,000 Births.
Ireland,	1884-88	94	Italy,	1884-91	192
Sweden,	1881-90	97	Prussia,	1886-92	207
Scotland,	1885-90	120	Hungary,	1884-87	212
England,	1885-91	144	Austria,	1886-87	246
Belgium,	1881-91	159	Saxony,	1886-92	281
France,	1885-90	165	Bavaria,	1879-88	287
Holland,	1885-90	179	*Massachusetts*,	1876-95	161

Dr. Schlossmann states the importance of this portion of the subject very tersely as follows: "The death of every child constitutes a definite loss of national wealth" ("Zeitschrift f. Hygiene," Vol. 24, page 19).

For the remaining age periods (five to ten years and upward) the following table may be consulted (page 756). In this table the column published in the registration report of 1890, page 294, "under one," is omitted in consequence of the serious defects in the census for children of that age. (See report of State Board of Health of 1894, page liv.) For the succeeding years up to age forty there has been a decrease in the death-rate at each period of life, as follows, comparing the figures of 1865 with those of 1895: —

TABLE 42. — *Death-rates per 1,000 Living at Certain Age Periods, 1865 and 1895.*

YEARS.	5-9.	10-14.	15-19.	20-29.	30-39.
1865,	9.63	5.14	9.63	12.58	11.68
1895,	6.23	3.18	5.34	7.08	9.67

On the other hand, the later ages of life present in each instance an increase in the death-rate, as follows: —

TABLE 43. — *Death-rates per 1,000 Living at Certain Age Periods, 1865 and 1895.*

YEARS.	40-49.	50-59.	60-69.	70-79.	80 and Over.
1865,	11.86	17.49	32.90	70.48	168.23
1895,	12.65	20.45	39.37	82.41	184.65

These figures show that while no very decided changes have taken place in the general death-rate during forty years (that of the first twenty years being 19.49 and that of the last twenty 19.51) very marked changes have taken place in the death-rates at different ages.

The causes and conditions under which these changes have taken place will be more fully considered under the head of "The Balance of Mortality," following the discussion of the "Causes of Death."

TABLE 44. — *Population, Deaths and Death-rates per 1,000 Living at Specified Ages, 1865–95.*

	All Ages	Under 5.	5 to 10.	10 to 15.	15 to 20.	20 to 30.	30 to 40.	40 to 50.	50 to 60.	60 to 70.	70 to 80.	80 and Over.	Unknown.
Population, 1865,	1,267,031	133,943	143,391	120,601	117,171	225,566	185,343	142,831	96,440	52,216	26,675	8,316	1,302
Deaths, 1865,	26,152	9,191	1,383	651	1,128	2,837	2,165	1,694	1,687	1,940	1,880	1,399	165
Death-rates, 1865,	20.64	68.62	9.63	5.14	9.63	12.58	11.68	11.86	17.49	33.90	70.48	168.23	-
Population, 1870,	1,457,351	156,889	139,796	143,871	142,164	274,859	214,151	162,689	108,348	68,401	31,896	9,727	41
Deaths, 1870,	27,339	9,873	825	536	1,027	2,833	2,275	1,947	1,837	2,038	2,196	1,654	196
Death-rates, 1870,	18.76	62.92	5.90	3.74	7.22	10.46	10.62	11.96	16.95	30.06	68.85	170.04	-
Population, 1875,	1,651,912	175,855	163,738	148,365	165,936	310,861	240,966	182,822	126,430	70,186	38,283	11,167	10,302
Deaths, 1875,	34,976	12,823	1,603	706	1,287	3,245	2,743	2,361	2,336	2,760	2,939	1,968	169
Death-rates, 1875,	21.17	73.06	9.77	4.72	7.73	10.49	11.30	12.97	18.29	34.79	71.11	176.41	-
Population, 1880,	1,783,085	179,307	171,595	161,425	167,606	343,701	264,413	203,515	142,083	81,619	44,337	13,525	-
Deaths, 1880,	35,292	12,213	1,463	611	1,104	3,269	2,721	2,384	2,538	3,104	3,243	2,480	183
Death-rates, 1880,	19.79	68.11	8.52	3.78	6.58	9.51	10.29	11.71	17.86	38.03	73.16	184.02	-
Population, 1885,	1,942,141	178,338	181,842	176,551	187,247	384,450	288,219	222,920	156,760	101,619	49,235	15,516	144
Deaths, 1885,	38,094	11,956	1,358	667	1,190	3,492	3,062	2,889	3,090	3,678	3,750	2,829	123
Death-rates, 1885,	19.61	67.00	7.46	3.77	6.35	9.08	10.62	12.96	19.71	36.19	76.16	182.32	-
Population, 1890,	2,238,943	208,756	196,578	192,229	214,613	465,387	341,692	253,181	178,121	114,172	55,686	17,866	6,501
Deaths, 1890,	43,526	13,870	1,282	697	1,361	3,931	3,552	3,396	3,642	4,286	4,247	3,115	149
Death-rates, 1890,	19.44	66.07	6.55	3.62	6.34	8.45	10.40	13.41	20.46	37.53	75.99	174.02	-
Population, 1895,	2,500,183	235,647	224,119	202,900	225,881	521,892	400,134	282,791	199,511	125,283	61,011	18,510	3,014
Deaths, 1895,	47,540	15,202	1,397	646	1,207	4,101	3,873	3,575	4,080	4,938	5,028	3,418	77
Death-rates, 1895,	19.01	64.51	6.23	3.18	5.34	7.06	9.67	12.65	20.45	39.37	82.41	184.65	-

NOTE. — The table on page 756 cannot be considered as an accurate table, from which precise conclusions can be drawn. Its chief merit lies in the fact that the figures selected for presentation are those of census years and hence more accurate than those which are estimated in the intervening years. The serious defect of the table consists in the fact that single years may at any time present unusual departures from the mean of a series. Thus in this table, 1865 was a year of unusually high death-rate, being much above the mean of the forty years 1856–95, and the death-rate of 1895 was also considerably below the mean. A much better method is that of comparing continuous series of years, as in tables 8, 19 and 31.

CAUSES OF DEATH.

It has been the custom in earlier summaries of the mortality of different countries to attach considerable importance to the broad and general groupings or classes of disease and causes of death; but in later years, and especially in many of the best foreign reports upon vital statistics, greater stress has been laid upon the presentation of diseases separately, without regard to their relation to each other. In the recent reports of the registration officer of Michigan a provisional classification has been adopted for temporary use, subject to such modification as medical progress may demand.

These changes have become necessary in consequence of the rapid advances in medicine, and in the knowledge of the causes and natural history of disease. As evidence of this may be cited the introduction of the term "diphtheria" in 1858 (a disease well known and observed before under other complex names), the separation of typhus from typhoid fever, the disuse of such meaningless names as nephria, metria, noma, etc., the gradual disuse of the term "zymotic," and the transfer of tuberculosis to a place among infectious diseases.

These considerations have more weight in the present summary (which embraces the statistics of forty years) than in the ordinary digest of the statistics of a single year.

In proof of the decided changes which have taken place in the mortality from different causes during the forty years under consideration the following table is presented, in which is shown the comparative order of fatality of the ten most destructive causes and groups of causes of death for the first and last ten years of the whole period. These two series of years are selected for the purpose of presenting the conditions prevailing at the beginning and close of

the period. For the same reasons the order of the years in the upper portion of the table is the reverse of that in the lower, in order that the two extreme years of the period (1856 and 1895) may be shown in contrast.

One circumstance which is clearly indicated by the figures in this table is the decidedly greater prevalence of epidemics in the former period as compared with the latter. This is indicated by the marked irregularity in the order of the figures in the columns representing the first ten years.

Table 45. — *Mortality from Ten Prominent Causes, 1856-65 and 1886-95.*

1856-65.

Causes of Death.	Deaths. 1856.	Rank — 1856-65.									
		1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.
Consumption,	4,701	1	1	1	1	1	1	1	1	[illegible]	1
Scarlet-fever,	1,252	2	2	5	5	4	5	3	6	5	10
Brain diseases,	1,093	3	4	2	2	2	2	2	4	3	2
Old age,	978	4	3	4	3	5	6	6	7	6	6
Pneumonia,	978	5	5	3	4	3	3	5	3	4	5
Typhoid fever,	960	6	6	6	6	7	8	7	5	7	3
Dysentery,	930	7	7	7	8	10	10	10	9	9	4
Heart diseases,	573	8	9	9	9	9	9	9	10	10	9
Cholera infantum,	555	9	8	8	7	6	4	8	8	8	8
Diphtheria and croup,	519	10	10	10	10	8	7	4	2	2	7
	12,539	–	–	–	–	–	–	–	–	–	–

1886-95.

Causes of Death.	Deaths. 1895.	Rank — 1886-95.									
		1895.	1894.	1893.	1892.	1891.	1890.	1889.	1888.	1887.	1886.
Consumption,	5,486	1	1	1	1	1	1	1	1	1	1
Brain diseases,	5,193	2	2	3	2	2	2	2	2	2	2
Pneumonia,	4,652	3	3	2	3	3	3	3	3	3	3
Heart diseases,	3,769	4	4	4	[illegible]	4	4	4	4	4	4
Cholera infantum,	2,377	5	5	5	5	5	6	5	5	5	5
Kidney diseases,	1,926	6	7	8	8	8	9	9	[illegible]	10	8
Diphtheria and croup,	1,784	7	6	10	9	10	5	6	7	7	7
Cancer,	1,749	8	10	9	10	9	8	8	10	9	9
Old age,	1,715	9	8	6	6	6	7	7	6	6	6
Bronchitis,	1,558	10	9	7	7	7	10	10	8	8	10
	30,209	–	–	–	–	–	–	–	–	–	–

An examination of Table 45 and of those on pages 762 and 764 shows that consumption has from the outset maintained the first place as the most destructive cause of death. The uniform diminution, however, in the mortality from this cause gives good reason for believing that in a very few years it will have disappeared from the head of the column. In 1856 the deaths from consumption were nearly four times as many as those of the next cause upon the list, while in 1895 the deaths from consumption exceeded those of the next destructive group of causes by a little more than 5 per cent. only.

A glance at the order of the figures in the two columns headed 1856 and 1865 shows that much more decided changes in the order of fatality had taken place in the early period than had occurred in the later period, comparing the columns for 1886 and 1895.

During the intervening period (1866–85) changes were still in progress, consumption maintaining the first place, and in one year (1872) only did small-pox attain sufficient importance to find a place in the table as the ninth cause in the order of destructiveness.

Croup was, during the first two years, the tenth cause, and diphtheria appears for the first time in 1858, and from that date croup and diphtheria are considered together. This group rapidly rose in its order of destructiveness from the tenth in 1856 to the second place in 1863 and 1864. A similar sudden accession of virulence occurred between 1872 and 1876, when diphtheria alone appears to have risen from the nineteenth place to the second in the course of five years. (See registration report of 1876, page 54.)

Another important change is that in the mortality from pneumonia, which has risen during the whole period from the fifth place in 1856 and 1857 to the third place in each year of the entire period 1886–95, except 1893, when it was second in rank. This change, too, has been comparatively uniform, though not so steadily maintained as the downward tendency in consumption.

Scarlet-fever, dysentery and typhoid fever have disappeared from the list, and their places are supplied by cancer, kidney diseases and bronchitis.

Further information in regard to these changes may be found under the title "The Balance of Mortality."

Deaths from Unknown or Unspecified Causes.

Under the term "causes not specified" it has been the custom to include all deaths certified as from *hemorrhage*, *tumor*, *inflammation* and *cause unknown*. Owing to changes in the methods of tabulation the number of deaths referred to this title, "causes not specified," was increased from 478 and a percentage of 2.1 of the total mortality in 1867, to 1,464 and a percentage of 5.7 in 1868. From the latter date down to 1895 there has been a comparatively uniform improvement, the percentages of this class being as follows for the successive years 1891–95: .90, .96, 1.1, 1.0 and .94.

While these figures represent an improvement, they do not show the serious defects which exist in the certification and tabulation of other deaths. These questions have been discussed by the Massachusetts Association of Boards of Health, and a partial method of relief was suggested, consisting in the modification of the present form of death certificate in such a manner as to convey to the certifying physician such information as would lead him to take greater pains in registering the cause of death with accuracy and sufficient fulness of detail.

As an example, the following terms convey but little accurate information, and in many cases wrong conclusions must be drawn from the mass of recorded facts. In 1895 there were 163 deaths recorded as from septicemia (no clue to its character being given), 88 from dropsy, 153 from mortification, 1,451 from cephalitis, 903 from cancer (the location being omitted), 703 from peritonitis, 1,163 infantile and premature, and 1,199 from atrophy and debility. These deaths, together with the 445 classed as from *cause not specified*, constitute more than 13 per cent. of all the deaths of that year, and while it is undoubtedly true that the causes of many deaths must necessarily be recorded in an indefinite manner, it is plain that great improvement is possible by more accurate certification, as well as by the system pursued by the British Registrar-General, and by the registration authorities of many states, of subjecting all doubtful returns to careful revision.

In the table on page 767 the deaths and death-rates presented in Table 46 are given in five-year periods, the percentages of total mortality being omitted.

Table 46.—Statistics of Certain Causes of Death, Massachusetts, 1856-75.

Deaths, and Ratios compared with Population and Total Mortality.

Years.	Small-pox.			Measles.			Scarlet-fever.			Diphtheria and Croup.			Typhoid Fever.		
	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.
1856,	140	1.2	0.68	174	1.5	0.84	1,252	10.9	6.04	519	4.5	2.50	960	8.3	4.63
1857,	29	0.2	0.11	101	0.9	0.47	2,018	17.3	9.46	518	4.4	2.43	1,010	8.6	4.75
1858,	12	0.1	0.06	301	2.5	1.45	1,061	8.8	5.06	516	4.3	2.48	901	7.6	4.34
1859,	256	2.1	1.22	110	0.9	0.52	1,006	8.3	4.80	560	4.6	2.67	932	7.7	4.44
1860,	324	2.7	1.46	224	1.8	0.97	916	7.4	3.97	867	6.8	3.63	937	7.6	4.06
1861,	33	0.3	0.14	209	1.7	0.87	1,137	9.2	4.72	1,104	8.9	4.55	989	8.0	4.11
1862,	40	0.3	0.17	360	3.0	1.61	1,261	10.1	5.40	1,147	9.2	4.99	1,136	9.1	4.94
1863,	42	0.3	0.15	141	1.1	0.61	1,399	11.2	6.04	2,284	18.2	8.23	1,442	11.5	5.20
1864,	242	1.9	0.84	320	2.6	1.11	1,503	11.9	5.23	1,999	15.9	6.95	1,344	10.7	4.67
1865,	221	1.7	0.84	136	1.1	0.52	807	6.4	3.09	1,176	9.3	4.50	1,694	13.4	6.45
1866,	141	1.1	0.60	109	0.8	0.46	385	3.0	1.63	830	6.4	3.61	1,091	8.4	4.82
1867,	196	1.5	0.96	194	1.4	0.86	838	6.2	3.64	607	4.5	2.67	965	7.2	4.24
1868,	20	0.1	0.08	287	2.1	1.12	1,369	9.9	6.26	782	5.7	3.06	896	6.5	3.59
1869,	59	0.4	0.23	222	1.6	0.85	1,405	9.9	5.39	769	5.4	2.96	1,205	8.5	4.63
1870,	131	0.9	0.48	269	1.8	0.96	658	4.7	2.50	676	4.6	2.47	1,333	9.1	4.88
1871,	295	2.0	1.06	131	0.9	0.47	867	5.6	3.10	747	5.0	2.67	1,116	7.5	3.99
1872,	1,029	6.7	2.94	423	2.8	1.22	1,377	9.0	3.93	753	4.9	2.16	1,708	11.1	4.88
1873,	666	4.3	1.97	180	1.1	0.53	1,472	9.4	4.34	746	4.7	2.20	1,406	8.9	4.15
1874,	26	0.2	0.06	161	1.0	0.50	1,382	8.6	4.53	913	5.7	2.86	1,147	7.1	3.60
1875,	34	0.2	0.10	233	1.4	0.67	1,684	10.2	4.81	1,880	11.4	5.38	1,060	6.4	3.06
Totals and means,	3,941	1.5	0.75	4,299	1.6	0.82	23,797	8.5	4.58	19,361	7.2	3.58	23,265	8.6	4.43

TABLE 46. — STATISTICS OF CERTAIN CAUSES OF DEATH, MASSACHUSETTS, 1856-75 — *Continued.*

Deaths, and Ratios compared with Population and Total Mortality — Continued.

YEARS.	CHOLERA INFANTUM.			CONSUMPTION.			CHILD-BIRTH.				DYSENTERY.	
	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Percentage of Births.	Deaths.	Death-rate per 10,000 Living.
1856,	565	4.8	2.69	4,701	40.8	22.67	197	1.7	0.95	.565	930	8.1
1857,	631	5.4	2.97	4,625	39.5	21.73	237	2.0	1.11	.664	715	6.1
1858,	720	6.0	3.47	4,674	38.4	22.09	226	1.9	1.09	.648	752	6.3
1859,	831	6.9	3.96	4,704	38.9	22.43	263	2.2	1.26	.735	613	5.1
1860,	1,078	8.8	4.67	4,557	37.0	19.75	290	2.4	1.30	.813	441	3.6
1861,	1,264	10.2	5.26	4,522	36.6	18.76	298	2.3	1.18	.784	532	4.3
1862,	900	7.2	3.92	4,299	34.3	18.58	197	1.6	0.86	.568	479	3.8
1863,	1,164	9.3	4.10	4,667	37.3	16.52	206	1.6	0.74	.603	1,166	9.3
1864,	1,196	9.5	4.16	4,723	37.6	16.46	212	1.7	0.74	.604	1,196	9.4
1865,	1,164	9.1	4.41	4,661	36.9	17.82	209	1.6	0.80	.678	1,548	12.2
1866,	1,078	8.3	4.56	4,600	35.3	19.46	245	1.9	1.04	.704	949	7.3
1867,	966	7.2	4.24	4,362	33.6	19.16	243	1.8	1.07	.660	656	4.9
1868,	1,661	11.8	6.10	4,487	32.2	17.33	271	2.0	1.06	.735	666	5.0
1869,	1,424	10.0	5.47	4,669	32.9	17.88	314	2.2	1.21	.861	481	3.4
1870,	1,914	13.1	7.00	5,003	34.3	18.31	323	2.2	1.18	.830	471	3.2
1871,	1,718	11.6	6.15	5,070	33.9	18.14	282	1.9	1.01	.691	389	2.6
1872,	3,254	21.2	9.29	5,556	36.3	16.87	338	2.2	0.96	.766	564	3.7
1873,	2,568	16.2	7.53	5,566	35.4	16.38	402	2.6	1.19	.867	435	2.8
1874,	2,322	14.4	7.28	5,284	32.8	16.57	414	2.6	1.30	.887	366	2.3
1875,	2,606	16.3	7.45	5,736	34.7	16.40	424	2.4	1.21	.943	437	2.6
Totals and means,	28,598	10.7	5.30	96,278	[illegible]7	18.81	5,584	2.1	1.06	.749	15,786	5.1

TABLE 46.—STATISTICS OF CERTAIN CAUSES OF DEATH, MASSACHUSETTS, 1876-95—*Continued.*

Deaths, and Ratios compared with Population and Total Mortality—Continued.

YEARS.	Small-pox. Deaths.	Small-pox. Death-rate per 10,000 Living.	Small-pox. Percentage of Total Mortality.	Measles. Deaths.	Measles. Death-rate per 10,000 Living.	Measles. Percentage of Total Mortality.	Scarlet-fever. Deaths.	Scarlet-fever. Death-rate per 10,000 Living.	Scarlet-fever. Percentage of Total Mortality.	Diphtheria and Croup. Deaths.	Diphtheria and Croup. Death-rate per 10,000 Living.	Diphtheria and Croup. Percentage of Total Mortality.	Typhoid Fever. Deaths.	Typhoid Fever. Death-rate per 10,000 Living.	Typhoid Fever. Percentage of Total Mortality.
1876,	31	.20	.09	47	0.3	0.14	1,222	7.3	3.68	3,294	19.6	9.92	861	5.3	2.65
1877,	34	.14	.06	135	0.8	0.43	467	2.7	1.40	3,178	18.7	10.14	814	4.8	2.60
1878,	2	.01	.01	305	1.8	0.97	404	2.3	1.29	2,517	14.6	8.04	679	3.9	2.17
1879,	7	.04	.02	19	0.1	0.06	850	4.6	2.67	2,293	13.1	7.21	637	3.6	2.00
1880,	38	.21	.11	236	1.3	0.67	574	3.2	1.63	2,204	13.4	6.76	853	4.9	2.40
1881,	47	.26	.13	230	1.3	0.63	397	2.2	1.00	2,383	13.1	6.64	1,072	5.9	2.94
1882,	45	.24	.12	68	0.4	0.18	316	1.7	0.86	1,771	9.6	4.61	1,079	5.8	2.93
1883,	5	.03	.01	331	1.7	0.85	575	3.1	1.52	1,621	8.6	4.29	860	4.6	2.28
1884,	3	.02	.01	75	0.4	0.20	627	3.3	1.60	1,646	8.6	4.45	875	4.6	2.37
1885,	20	.10	.05	313	1.6	0.83	567	3.0	1.54	1,523	7.8	4.00	768	3.9	2.02
1886,	–	–	–	130	0.6	0.35	331	1.7	0.89	1,555	7.8	4.16	800	4.0	2.15
1887,	2	.01	.007	455	2.2	1.13	594	2.9	1.46	1,623	7.9	3.90	922	4.5	2.25
1888,	8	.04	.02	319	1.0	0.82	504	2.4	1.20	1,631	8.7	4.35	943	4.5	2.24
1889,	6	.03	.01	171	0.8	0.41	186	0.9	0.44	2,214	10.2	5.30	891	4.1	2.13
1890,	1	.004	.002	114	0.5	0.26	196	0.9	0.45	1,626	7.3	3.74	855	3.7	1.94
1891,	1	.004	.002	236	1.0	0.52	246	1.1	0.54	1,218	5.3	2.70	821	3.6	1.82
1892,	2	.01	.004	85	0.4	0.15	669	2.9	1.57	1,455	6.3	2.96	827	3.5	1.70
1893,	9	.04	.02	275	1.2	0.56	810	2.4	1.65	1,394	5.8	2.84	750	3.1	1.53
1894,	28	.12	.07	96	0.4	0.21	649	2.6	1.30	1,601	7.4	3.85	748	3.1	1.60
1895,	–	–	–	117	0.5	0.25	463	1.9	1 02	1,764	7.1	3.75	680	2.7	1.43
Totals and means,	284	.07	.04	3,653	0.9	0.46	10,682	2.6	1.35	32,129	9.6	4.94	16,764	4.1	2.12

TABLE 46.—STATISTICS OF CERTAIN CAUSES OF DEATH, MASSACHUSETTS, 1876 95 — *Continued.*

Deaths, and Ratios compared with Population and Total Mortality — Continued.

Years.	Cholera Infantum. Deaths.	Cholera Infantum. Death-rate per 10,000 Living.	Cholera Infantum. Percentage of Total Mortality.	Consumption. Deaths.	Consumption. Death-rate per 10,000 Living.	Consumption. Percentage of Total Mortality.	Child-birth. Deaths.	Child-birth. Death-rate per 10,000 Living.	Child-birth. Percentage of Total Mortality.	Child-birth. Percentage of Births.	Dysentery. Deaths.	Dysentery. Death-rate per 10,000 Living.
1876,	2,087	12.4	6.29	5,327	31.8	16.05	381	2.3	1.15	.865	417	2.5
1877,	1,937	11.3	6.15	5,457	32.0	17.41	275	1.6	0.88	.644	580	3.4
1878,	1,573	9.1	5.09	5,334	30.8	17.04	297	1.7	0.95	.706	602	3.5
1879,	1,349	7.7	4.24	5,228	29.7	16.42	300	1.7	0.94	.728	372	2.1
1880,	2,118	11.9	6.06	5,494	30.8	15.57	316	1.8	0.90	.700	395	2.2
1881,	1,861	10.3	5.10	5,886	32.4	16.14	370	2.0	1.01	.799	360	2.0
1882,	2,150	11.7	5.67	5,665	31.8	16.94	351	1.9	0.95	.751	398	2.2
1883,	1,941	10.3	5.14	5,931	31.6	15.71	366	1.9	0.97	.755	336	1.8
1884,	2,051	10.9	5.66	5,798	30.4	15.67	323	1.7	0.87	.649	254	1.3
1885,	1,852	9.5	4.66	5,954	30.7	15.63	350	1.8	0.92	.700	253	1.3
1886,	1,931	9.7	5.18	5,897	29.5	15.85	305	1.5	0.81	.581	249	1.3
1887,	2,131	10.4	5.29	5,871	28.6	14.40	290	1.4	0.69	.514	266	1.3
1888,	2,196	10.4	5.21	5,735	27.1	13.61	277	1.3	0.66	.491	248	1.3
1889,	2,156	9.9	5.16	5,661	26.7	13.36	305	1.4	0.73	.517	296	1.4
1890,	2,491	11.1	5.72	5,791	25.9	13.31	365	1.6	0.84	.616	220	1.0
1891,	2,771	12.1	6.13	5,484	24.0	12.14	269	1.2	0.60	.416	234	1.0
1892,	2,896	12.4	5.94	5,739	24.5	11.77	343	1.5	0.70	.506	193	0.8
1893,	2,704	11.3	5.51	5,527	23.1	11.26	317	1.3	0.65	.450	231	1.0
1894,	2,676	10.9	5.72	5,463	22.3	11.67	325	1.3	0.69	.474	216	0.9
1895,	2,377	9.5	5.00	5,466	21.9	11.54	380	1.5	0.80	.549	209	0.8
Totals and means,	43,278	10.7	5.47	112,537	27.8	14.25	6,491	1.6	0.82	.604	6,306	1.6

TABLE 46.—STATISTICS OF CERTAIN CAUSES OF DEATH, MASSACHUSETTS, 1856–75—*Continued.*

Deaths, and Ratios compared with Population and Total Mortality—Continued.

YEARS.	PNEUMONIA.			WHOOPING-COUGH.			CANCER.			KIDNEY DISEASES.			HEART DISEASES.			BRAIN DISEASES.		
	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.
1856, . . .	978	8.5	4.72	232	2.0	1.12	217	1.9	1.06	51	0.4	0.24	573	5.0	2.76	1,079	9.4	5.20
1857, . . .	1,075	9.2	5.05	280	2.4	1.32	242	2.1	1.14	46	0.4	0.21	586	5.0	2.75	1,122	9.7	5.39
1858, . . .	1,174	9.9	5.65	347	3.0	1.67	289	2.4	1.30	43	0.4	0.20	579	4.9	2.79	1,232	10.3	5.93
1859, . . .	1,167	9.6	5.54	357	2.9	1.70	306	2.5	1.46	56	0.5	0.26	592	4.9	2.82	1,233	10.2	5.88
1860, . . .	1,333	10.6	5.78	203	1.6	0.88	335	2.7	1.45	67	0.5	0.29	690	5.6	2.99	1,422	11.6	6.16
1861, . . .	1,236	10.4	5.34	405	3.3	1.69	336	2.7	1.40	91	0.7	0.37	735	5.9	3.06	1,497	12.1	6.22
1862, . . .	1,140	9.2	4.96	254	2.0	1.11	319	2.6	1.39	96	0.8	0.41	702	5.6	3.06	1,417	11.4	6.17
1863, . . .	1,724	13.8	6.31	296	2.4	1.06	324	2.6	1.17	111	0.9	0.40	809	6.5	2.92	1,677	13.6	5.98
1864, . . .	1,801	14.3	6.26	233	1.8	0.52	330	2.6	1.15	130	1.0	0.45	768	6.1	2.67	1,913	15.2	6.65
1865, . . .	1,493	11.8	5.71	369	2.9	1.39	375	3.0	1.43	178	1.4	0.68	806	6.3	3.06	1,761	13.9	6.73
1866, . . .	1,630	12.6	6.98	287	2.2	1.21	416	3.2	1.76	135	1.0	0.57	834	6.4	3.53	1,721	13.2	7.28
1867, . . .	1,378	10.3	6.05	297	2.2	1.30	395	2.9	1.73	161	1.2	0.71	864	6.4	3.79	1,650	12.3	7.26
1868, . . .	1,651	12.0	6.45	247	1.8	0.96	445	3.2	1.74	206	1.5	0.80	971	7.0	3.79	1,935	14.0	7.56
1869, . . .	1,736	12.3	6.66	320	2.3	1.23	492	3.5	1.89	239	1.7	0.92	906	6.4	3.47	1,928	13.6	7.40
1870, . . .	1,718	11.9	6.29	330	2.3	1.21	516	3.5	1.89	285	2.0	1.05	962	6.6	3.52	2,074	14.2	7.59
1871, . . .	1,858	12.4	6.65	243	1.6	0.87	551	3.7	1.97	365	2.4	1.31	1,134	7.6	4.06	2,171	14.5	7.77
1872, . . .	2,295	15.0	6.55	363	2.4	1.04	542	3.5	1.65	376	2.5	1.07	1,202	7.8	3.43	2,771	18.1	7.91
1873, . . .	2,097	13.4	6.18	264	1.7	0.78	611	3.9	1.80	460	2.9	1.36	1,236	7.9	3.64	2,598	16.9	7.48
1874, . . .	2,388	14.8	7.48	449	2.8	1.41	585	3.6	1.83	463	2.9	1.44	1,272	7.9	3.99	2,413	15.0	7.67
1875, . . .	2,940	17.6	8.40	242	1.5	0.69	603	3.6	1.69	509	3.1	1.46	1,331	8.1	3.81	2,390	15.7	7.45
Totals and means,	32,868	12.2	6.25	6,014	2.3	1.14	8,319	3.0	1.56	4,062	1.5	0.77	17,050	6.5	3.34	36,054	13.4	6.88

TABLE 46. — STATISTICS OF CERTAIN CAUSES OF DEATH, MASSACHUSETTS, 1876-95 — *Concluded.*

Deaths, and Ratios compared with Population and Total Mortality — Concluded.

Years	Pneumonia.			Whooping-cough.			Cancer.			Kidney Diseases.			Heart Diseases.			Brain Diseases.		
	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.
1876,	2,447	14.6	7.37	192	1.1	0.58	657	3.9	1.98	488	2.9	1.47	1,335	8.0	4.02	2,507	14.9	7.55
1877,	1,972	11.6	6.29	369	2.2	1.18	640	3.8	2.05	535	3.1	1.71	1,354	8.0	4.32	2,521	14.8	8.04
1878,	2,171	12.6	6.93	400	2.3	1.28	807	4.7	2.58	615	3.6	1.96	1,442	8.3	4.61	2,775	16.1	8.87
1879,	2,647	15.1	8.32	302	1.7	0.95	862	4.9	2.71	693	3.9	2.18	1,515	8.6	4.76	2,820	16.1	8.87
1880,	3,076	17.3	8.72	230	1.3	0.65	928	5.2	2.63	698	3.9	1.98	1,726	9.7	4.89	3,210	18.0	9.10
1881,	2,967	16.4	8.14	217	1.2	0.59	949	5.2	2.60	825	4.5	2.26	1,937	10.7	5.31	3,356	18.6	9.20
1882,	2,932	15.9	7.97	265	1.4	0.72	987	5.3	2.68	877	4.7	2.38	2,025	11.0	5.50	3,393	18.4	9.23
1883,	3,045	16.2	8.07	137	0.7	0.36	1,026	5.5	2.72	959	5.1	2.54	2,153	11.5	5.70	3,562	19.0	9.44
1884,	2,646	13.9	7.16	410	2.1	1.11	1,060	5.6	2.87	1,000	5.2	2.70	2,117	11.1	5.72	3,669	19.3	9.93
1885,	3,466	17.9	9.10	184	0.9	0.48	1,087	5.6	2.85	1,088	5.6	2.86	2,227	11.5	5.85	3,891	20.0	10.22
1886,	2,836	14.2	7.61	271	1.4	0.73	1,104	5.5	2.96	1,135	5.7	3.05	2,325	11.6	6.24	3,844	19.2	10.32
1887,	3,318	16.5	8.21	282	1.1	0.67	1,174	5.7	2.88	1,120	5.4	2.75	2,690	13.1	6.60	4,257	20.7	10.44
1888,	3,716	17.6	8.83	245	1.2	0.58	1,275	6.0	3.03	1,318	6.2	3.13	3,061	14.5	7.27	4,522	21.4	10.74
1889,	3,440	15.8	8.23	310	1.4	0.74	1,325	6.1	3.17	1,258	5.8	3.01	3,280	15.1	7.85	4,313	19.8	10.32
1890,	4,038	18.0	9.28	263	1.6	0.58	1,387	6.2	3.19	1,273	5.7	2.92	3,417	15.3	7.85	4,380	19.6	10.06
1891,	4,337	18.9	9.60	219	1.0	0.48	1,395	6.1	3.09	1,474	6.4	3.26	3,592	15.7	7.95	4,711	20.6	10.42
1892,	5,020	21.5	10.80	248	1.1	0.51	1,402	6.0	2.88	1,535	6.6	3.15	3,733	16.0	7.65	5,036	21.5	10.35
1893,	5,499	23.0	11.20	274	1.1	0.56	1,533	6.4	3.12	1,685	7.0	3.43	3,511	14.7	7.15	5,144	21.5	10.48
1894,	4,101	16.5	8.76	435	1.8	0.93	1,568	6.4	3.36	1,721	7.0	3.68	3,432	14.0	7.33	4,996	20.4	10.67
1895,	4,652	18.6	9.79	269	1.1	0.57	1,749	7.0	3.68	1,860	7.4	3.91	3,566	14.3	7.50	5,062	20.2	10.66
Totals and means,	66,356	16.8	8.65	5,572	1.4	0.70	22,921	5.6	2.90	22,157	5.5	2.90	50,480	12.4	6.37	77,062	19.3	9.[illegible]

TABLE 47. — *Deaths and Death-rates from Certain Diseases and Groups of Diseases by Five-year Periods, 1856-95.*

Five year Periods.	Small-pox.		Measles.		Scarlet-fever.		Diphtheria and Croup.		Typhoid Fever.		Dysentery		Cholera Infantum.		Consumption.	
	Deaths.	Death-rate per 10,000 Living.	Deaths.	Death-rate per 10,000 Living.	Deaths.	Death-rate per 10,000 Living.	Deaths.	Death-rate per 10,000 Living.	Deaths.	Death-rate per 10,000 Living.	Deaths.	Death-rate per 10,000 Living.	Deaths.	Death-rate per 10,000 Living.	Deaths.	Death-rate per 10,000 Living.
1856-60, ...	764	1.3	910	1.5	6,238	10.6	2,940	4.9	4,740	8.0	3,450	5.8	3,816	6.4	23,161	38.9
1861-65, ...	578	.9	1,175	1.9	6,107	9.7	7,710	12.3	6,604	10.5	4,901	7.8	5,682	9.1	22,852	36.5
1866-70, ...	547	.8	1,061	1.6	4,670	6.8	3,664	5.3	5,490	8.0	3,244	4.7	6,943	10.1	23,061	33.4
1871-75, ...	2,062	2.6	1,133	1.4	6,782	8.6	5,038	6.4	6,431	8.2	2,191	2.8	12,453	15.8	27,204	34.6
1876-80, ...	102	.1	742	.9	3,517	4.1	13,676	15.5	3,893	4.5	2,366	2.7	9,054	10.5	26,835	31.0
1881-85, ...	119	.1	1,007	1.1	2,604	2.7	8,944	9.5	4,664	5.0	1,601	1.7	9,894	10.5	29,435	31.4
1886-90, ...	18	.02	1,060	1.0	1,810	1.7	5,857	5.4	4,391	4.1	1,276	1.2	10,904	10.3	28,868	27.3
1891-95, ...	45	.04	815	.7	2,857	2.4	7,662	6.4	3,836	3.2	1,083	.9	13,426	11.2	27,699	23.1

Deaths and Death-rates from Certain Diseases and Groups of Diseases by Five-year Periods, 1856-95 — Concluded.

Five-year Periods.	Child-birth.		Pneumonia.		Whooping-cough		Cancer.		Kidney Diseases.		Heart Diseases.		Brain Diseases.	
	Deaths.	Death-rate per 10,000 Living.	Deaths.	Death-rate per 10,000 Living.	Deaths.	Death-rate per 10,000 Living.	Deaths.	Death-rate per 10,000 Living.	Deaths.	Death-rate per 10,000 Living.	Deaths.	Death-rate per 10,000 Living.	Deaths.	Death-rate per 10,000 Living.
1856-60, ...	1,222	2.0	5,727	9.6	1,419	2.4	1,359	2.3	261	.4	3,030	5.1	6,098	10.2
1861-65, ...	1,106	1.8	7,443	11.9	1,553	2.5	1,684	2.7	601	1.0	3,819	6.1	8,165	13.0
1866-70, ...	1,396	2.0	8,124	11.6	1,481	2.1	2,264	3.3	1,027	1.5	4,536	6.6	9,308	13.5
1871-75, ...	1,860	2.4	11,576	14.7	1,561	2.0	2,882	3.7	2,173	2.8	6,175	7.9	12,483	15.9
1876-80, ...	1,569	1.8	12,318	14.2	1,493	1.7	3,900	4.5	3,029	3.5	7,373	8.5	13,536	16.0
1881-85, ...	1,760	1.9	15,068	16.0	1,213	1.3	6,109	6.4	4,749	5.1	10,459	11.1	17,875	19.0
1886-90, ...	1,528	1.4	17,378	16.4	1,421	1.3	6,265	5.9	6,104	5.8	14,775	14.0	21,325	20.1
1891-95, ...	1,634	1.4	23,600	19.7	1,446	1.2	7,647	6.4	8,275	6.9	17,884	14.9	24,948	20.8

TABLE 48.—*Deaths from Each of Several Specified Causes, by Sexes, Months and at Different Periods of Life, during the Twenty Years 1856-75.*

	1856-75.	Small-pox.	Measles	Scarlet-fever.	Diphtheria.	Croup	Typhoid Fever.	Dysentery	Cholera Infantum	Consumption.	Pneumonia.
	Totals,	3,928	4,299	23,797	8,961	10,380	23,265	13,755	28,898	86,278	32,868
SEX.	Males,	2,367	2,229	11,900	4,214	5,466	12,177	6,860	15,291	41,314	17,095
	Females,	1,556	2,068	11,883	4,738	4,901	11,078	6,870	13,557	32,941	15,758
	Unknown,	5	2	14	9	13	10	25	46	23	15
MONTHS.	January,	568	294	2,685	672	1,181	1,527	131	127	8,065	3,778
	February,	377	346	2,848	656	1,005	1,305	132	111	7,666	3,992
	March,	352	441	2,587	646	1,028	1,338	141	148	8,694	4,455
	April,	328	466	2,395	572	830	1,265	166	184	8,829	3,752
	May,	354	531	2,239	531	699	1,146	190	221	8,574	3,146
	June,	244	535	1,896	523	492	1,066	340	578	7,291	1,870
	July,	233	516	1,634	559	392	1,852	1,771	6,413	7,586	1,291
	August,	152	407	1,270	556	420	2,886	4,465	11,806	8,200	1,063
	September,	184	179	1,119	779	612	3,232	4,052	6,934	8,249	1,316
	October,	248	144	1,411	1,022	1,015	3,807	1,756	2,117	7,995	1,978
	November,	337	192	1,965	1,116	1,341	2,824	411	392	7,702	2,721
	December,	548	244	2,450	1,113	1,358	2,066	180	152	7,566	3,473
	Not stated,	3	5	8	6	2	23	12	6	63	11
	Under 5,	1,314	3,446	10,179	4,419	8,978	2,238	8,010	28,864	6,498	12,912
	5 to 10,	271	260	5,041	2,406	1,245	1,469	385	9	1,077	1,084

TABLE 49.—*Mean Annual Death-rate per 10,000 of the Living Population from Each of Several Specified Causes, Death-rate of Each Sex and at Different Periods of Life, with the Mortality by Months reduced to a Standard Mean of 100, for the Twenty Years 1856-75.*

	1856-75.	Small-pox.	Measles.	Scarlet-fever.	Diphtheria	Croup.	Typhoid Fever.	Dysentery.	Cholera Infantum.	Consumption.	Pneumonia.
	Totals,	1.46	1.59	8.82	3.33	3.85	8.62	5.11	10.71	35.70	12.19
SEX.	Males,	1.82	1.72	9.17	3.25	4.21	9.39	5.31	11.78	33.39	13.18
	Females,	1.11	1.48	8.49	3.40	3.50	7.91	4.91	9.68	37.82	11.26
MONTHS.	January,	170.4	80.6	133.0	114.4	134.0	77.3	11.2	5.2	98.7	135.5
	February,	124.1	104.1	127.6	99.1	125.2	66.8	12.4	5.0	103.0	157.0
	March,	105.6	120.9	128.1	84.8	116.7	67.8	12.1	6.0	106.4	159.7
	April,	101.7	132.0	122.5	77.5	97.3	66.2	14.7	7.7	105.3	139.0
	May,	106.2	145.5	110.9	69.7	79.4	58.0	16.2	9.0	104.9	112.8
	June,	75.6	151.5	96.5	70.9	57.7	55.8	30.0	24.4	92.2	69.3
	July,	69.9	141.1	75.9	73.2	44.5	70.0	151.4	261.6	92.8	46.3
	August,	45.6	111.5	62.9	72.9	47.7	120.8	381.7	469.6	100.3	38.8
	September,	57.0	50.7	57.3	105.6	71.8	169.1	357.9	292.2	104.3	48.8
	October,	74.4	39.5	69.9	134.1	115.2	192.8	152.6	86.3	97.8	70.9
	November,	104.5	54.4	95.4	151.3	158.4	147.8	36.3	16.5	97.4	100.8
	December,	164.4	66.9	121.3	146.0	153.5	104.6	16.2	6.2	96.2	124.5
AGES.	Under 5,	4.46	11.70	54.90	14.99	30.44	7.59	27.18	98.00	22.02	43.80
	5 to 10,	.99	1.38	20.19	9.18	4.54	5.35	3.22	.003	3.92	3.77
	10 to 15,	.43	.27	4.35	3.07	.37	6.43	.99	-	6.72	1.61
	15 to 20,	1.25	.34	1.54	1.42	.08	12.75	.87	-	32.61	3.01
	20 to 30,	2.06	.29	.61	.74	.03	10.93	.98	-	51.75	3.86
	30 to 40,	1.00	.15	.29	.62	.02	6.86	1.29	-	46.75	5.58
	40 to 50,	.62	.13	.15	.34	.02	6.25	1.81	-	42.21	8.37
	50 to 60,	.78	.09	.14	.31	.01	8.21	3.28	-	46.26	14.11
	60 to 70,	.67	.13	.10	.49	.01	12.69	6.42	-	64.97	28.35
	70 to 80,	.77	.38	.11	.71	.02	21.32	16.54	-	87.64	62.30
	Over 80,	1.52	.47	.17	.29	.06	24.68	32.53	-	62.32	97.69

TABLE 46.— STATISTICS OF CERTAIN CAUSES OF DEATH, MASSACHUSETTS, 1856-75 — *Continued.*

Deaths, and Ratios compared with Population and Total Mortality — Continued.

YEARS.	CHOLERA INFANTUM.			CONSUMPTION.			CHILD-BIRTH.				DYSENTERY.	
	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living	Percentage of Total Mortality	Deaths.	Death-rate per 10,000 Living	Percentage of Total Mortality	Percentage of Births.	Deaths.	Death-rate per 10,000 Living
1856,	555	4.8	2.66	4,701	40.8	23.67	197	1.7	0.95	.566	930	8.1
1857,	631	5.4	2.97	4,625	39.5	21.73	237	2.0	1.11	.664	715	6.1
1858,	720	6.0	3.47	4,574	38.4	22.02	226	1.9	1.09	.648	752	6.3
1859,	831	6.9	3.96	4,704	38.9	22.43	263	2.2	1.26	.735	612	5.1
1860,	1,078	8.8	4.67	4,557	37.0	19.75	299	2.4	1.30	.812	441	3.6
1861,	1,266	10.2	5.26	4,522	36.6	18.78	283	2.3	1.18	.754	532	4.3
1862,	900	7.2	3.92	4,269	34.3	18.58	197	1.6	0.86	.588	479	3.8
1863,	1,164	9.3	4.19	4,667	37.3	16.82	206	1.6	0.74	.603	1,156	9.2
1864,	1,198	9.5	4.16	4,733	37.6	16.46	212	1.7	0.74	.664	1,186	9.4
1865,	1,154	9.1	4.41	4,661	36.9	17.82	209	1.6	0.80	.678	1,548	12.2
1866,	1,078	8.3	4.56	4,600	35.3	19.46	245	1.9	1.04	.704	949	7.3
1867,	966	7.2	4.24	4,362	32.6	19.16	243	1.8	1.07	.690	655	4.9
1868,	1,561	11.8	6.10	4,437	32.2	17.33	271	2.0	1.06	.735	685	5.0
1869,	1,424	10.0	5.47	4,659	32.9	17.38	314	2.2	1.21	.851	481	3.4
1870,	1,914	13.1	7.00	5,003	34.3	18.31	323	2.2	1.18	.830	471	3.2
1871,	1,718	11.5	6.15	5,070	33.9	18.14	282	1.9	1.01	.691	389	2.6
1872,	3,264	21.2	9.29	5,556	36.3	16.87	336	2.2	0.96	.766	564	3.7
1873,	2,568	16.2	7.53	5,556	35.4	16.38	402	2.6	1.19	.887	435	2.8
1874,	2,322	14.4	7.28	5,284	32.8	16.57	414	2.6	1.30	.887	366	2.3
1875,	2,606	15.8	7.46	5,738	34.7	16.40	424	2.6	1.21	.948	437	2.6
Totals and means, .	28,893	10.7	5.60	96,276	35.7	18 31	5,584	2.1	1.06	.749	13,786	5.1

TABLE 46.— STATISTICS OF CERTAIN CAUSES OF DEATH, MASSACHUSETTS, 1876-95 — *Continued.*

Deaths, and Ratios compared with Population and Total Mortality — Continued.

YEARS.	SMALL-POX.			MEASLES.			SCARLET-FEVER.			DIPHTHERIA AND CROUP.			TYPHOID FEVER.		
	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living	Percentage of Total Mortality.
1876,	31	.20	.09	47	0.3	0.14	1,223	7.3	3.68	3,294	19.6	9.92	881	5.3	2.65
1877,	24	.14	.06	135	0.6	0.43	467	2.7	1.49	3,176	18.7	10.14	814	4.8	2.60
1878,	2	.01	.01	305	1.5	0.97	404	2.3	1.29	2,617	14.6	8.04	679	3.9	2.17
1879,	7	.04	.02	19	0.1	0.06	850	4.8	2.67	2,293	13.1	7.21	657	3.6	2.00
1880,	38	.21	.11	236	1.3	0.67	674	3.2	1.63	2,304	13.4	6.76	852	4.9	2.50
1881,	47	.26	.13	230	1.3	0.63	397	2.2	1.09	2,383	13.1	6.54	1,072	5.9	2.94
1882,	45	.24	.12	66	0.4	0.16	318	1.7	0.86	1,771	9.6	4.81	1,079	5.8	2.93
1883,	5	.03	.01	321	1.7	0.86	575	3.1	1.52	1,621	8.6	4.29	860	4.6	2.28
1884,	8	.03	.01	75	0.4	0.20	627	3.3	1.69	1,646	8.6	4.45	875	4.6	2.37
1885,	19	.10	.05	215	1.6	0.92	587	3.0	1.54	1,523	7.8	4.00	768	3.9	2.02
1886,	–	–	–	130	0.6	0.35	331	1.7	0.80	1,508	7.5	4.18	800	4.0	2.15
1887,	3	.01	.007	465	2.2	1.12	594	2.9	1.46	1,626	7.9	3.99	922	4.5	2.26
1888,	8	.04	.02	219	1.0	0.52	504	2.4	1.20	1,631	6.7	4.35	945	4.5	2.24
1889,	6	.03	.01	171	0.8	0.41	186	0.9	0.44	2,214	10.2	5.30	891	4.1	2.15
1890,	1	.004	.002	114	0.5	0.26	196	0.9	0.45	1,626	7.3	3.74	835	3.7	1.93
1891,	1	.004	.002	236	1.0	0.52	246	1.1	0.54	1,218	5.3	2.70	821	3.6	1.82
1892,	2	.01	.004	86	0.4	0.18	669	2.9	1.57	1,455	6.2	2.96	837	3.6	1.70
1893,	5	.04	.02	276	1.2	0.66	810	3.4	1.65	1,394	5.8	2.84	750	3.1	1.53
1894,	33	.13	.07	98	0.4	0.21	649	2.6	1.30	1,301	7.4	3.35	748	3.1	1.60
1895,	–	–	–	117	0.5	0.25	483	1.9	1.02	1,764	7.1	3.75	650	2.7	1.43
Totals and means,	284	.07	.04	3,653	0.9	0.46	10,668	2.6	1.35	39,129	9.6	4.94	16,764	4.1	2.12

TABLE 46.—STATISTICS OF CERTAIN CAUSES OF DEATH, MASSACHUSETTS, 1876 95—*Continued.*

Deaths, and Ratios compared with Population and Total Mortality—Continued.

YEARS.	CHOLERA INFANTUM.			CONSUMPTION.			CHILD-BIRTH.				DYSENTERY.	
	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Percentage of Births.	Deaths.	Death-rate per 10,000 Living.
1876,	2,087	12.4	6.29	5,327	31.9	16.06	381	2.3	1.15	.885	417	2.5
1877,	1,927	11.8	6.15	5,457	32.6	17.41	276	1.6	0.88	.644	580	3.4
1878,	1,573	9.1	5.02	5,334	30.8	17.04	297	1.7	0.95	.706	602	3.5
1879,	1,349	7.7	4.24	5,225	29.7	16.42	300	1.7	0.94	.726	372	2.1
1880,	2,118	11.9	6.00	5,494	30.8	15.57	316	1.8	0.90	.700	395	2.2
1881,	1,861	10.3	5.10	5,886	32.4	16.14	370	2.0	1.01	.790	360	2.0
1882,	2,159	11.7	5.57	5,865	31.8	15.94	351	1.9	0.95	.751	398	2.2
1883,	1,941	10.3	5.14	5,931	31.6	15.71	356	1.9	0.97	.765	336	1.8
1884,	2,081	10.9	5.65	5,796	30.4	15.67	323	1.7	0.87	.649	254	1.3
1885,	1,852	9.5	4.86	5,966	30.7	15.63	350	1.8	0.92	.700	253	1.3
1886,	1,931	9.7	5.18	5,897	29.5	15.83	303	1.5	0.81	.581	243	1.2
1887,	2,131	10.4	5.23	5,671	28.0	14.40	280	1.4	0.69	.514	266	1.3
1888,	2,195	10.4	5.21	5,728	27.1	13.61	277	1.3	0.66	.491	248	1.2
1889,	2,156	9.8	5.16	5,561	26.7	13.30	305	1.4	0.73	.517	299	1.4
1890,	2,491	11.1	5.72	5,791	25.9	13.31	365	1.6	0.84	.615	220	1.0
1891,	2,771	12.1	6.13	5,484	24.0	12.14	269	1.2	0.60	.416	234	1.0
1892,	2,898	12.4	5.94	5,739	24.5	11.77	345	1.5	0.70	.508	198	0.8
1893,	2,704	11.3	5.61	5,527	23.1	11.26	317	1.3	0.65	.459	231	1.0
1894,	2,676	10.9	5.72	5,463	22.2	11.67	325	1.3	0.69	.474	216	0.9
1895,	2,377	9.5	5.00	5,486	21.9	11.54	380	1.5	0.80	.549	209	0.8
Totals and means,	43,276	10.7	5.47	112,837	27.8	14.26	6,491	1.6	0.82	.604	6,326	1.6

TABLE 46.—STATISTICS OF CERTAIN CAUSES OF DEATH, MASSACHUSETTS, 1856–75—*Continued.*

Deaths, and Ratios compared with Population and Total Mortality—Continued.

Years.	Pneumonia. Deaths.	Pneumonia. Death-rate per 10,000 Living.	Pneumonia. Percentage of Total Mortality.	Whooping-cough. Deaths.	Whooping-cough. Death-rate per 10,000 Living.	Whooping-cough. Percentage of Total Mortality.	Cancer. Deaths.	Cancer. Death-rate per 10,000 Living.	Cancer. Percentage of Total Mortality.	Kidney Diseases. Deaths.	Kidney Diseases. Death-rate per 10,000 Living.	Kidney Diseases. Percentage of Total Mortality.	Heart Diseases. Deaths.	Heart Diseases. Death-rate per 10,000 Living.	Heart Diseases. Percentage of Total Mortality.	Brain Diseases. Deaths.	Brain Diseases. Death-rate per 10,000 Living.	Brain Diseases. Percentage of Total Mortality.
1856, . . .	978	8.5	4.72	232	2.0	1.12	217	1.9	1.05	41	0.4	0.24	573	5.0	2.76	1,079	9.4	5.20
1857, . . .	1,078	9.2	5.06	280	2.4	1.32	242	2.1	1.14	45	0.4	0.21	586	5.0	2.75	1,133	9.7	5.32
1858, . . .	1,174	9.9	5.65	347	2.9	1.67	289	2.4	1.39	42	0.4	0.20	579	4.9	2.79	1,232	10.3	5.93
1859, . . .	1,167	9.6	5.54	357	2.9	1.70	306	2.5	1.46	56	0.5	0.26	592	4.9	2.82	1,233	10.2	5.86
1860, . . .	1,333	10.8	5.79	203	1.6	0.88	335	2.7	1.46	67	0.5	0.29	690	5.6	2.99	1,422	11.6	6.18
1861, . . .	1,285	10.4	5.34	406	3.3	1.69	336	2.7	1.40	91	0.7	0.37	735	5.9	3.05	1,497	12.1	6.22
1862, . . .	1,140	9.2	4.96	254	2.0	1.11	319	2.6	1.39	96	0.8	0.41	702	5.6	3.06	1,417	11.4	6.17
1863, . . .	1,724	13.8	6.21	295	2.4	1.06	324	2.6	1.17	111	0.9	0.40	809	6.5	2.92	1,577	12.6	5.68
1864, . . .	1,801	14.3	6.26	235	1.9	0.82	330	2.6	1.16	130	1.0	0.45	768	6.1	2.67	1,913	15.2	6.65
1865, . . .	1,493	11.8	5.71	348	2.9	1.39	375	3.0	1.48	173	1.4	0.68	805	6.3	3.08	1,761	13.9	6.73
1866, . . .	1,639	12.6	6.93	287	2.2	1.21	416	3.2	1.76	135	1.0	0.57	834	6.4	3.53	1,731	13.2	7.32
1867, . . .	1,378	10.3	6.05	297	2.2	1.30	393	2.9	1.73	161	1.2	0.71	864	6.4	3.79	1,650	12.3	7.25
1868, . . .	1,651	12.0	6.45	247	1.8	0.96	446	3.2	1.74	206	1.5	0.80	971	7.0	3.79	1,935	14.0	7.56
1869, . . .	1,736	12.3	6.66	320	2.3	1.23	493	3.5	1.89	239	1.7	0.92	906	6.4	3.47	1,929	13.6	7.40
1870, . . .	1,718	11.9	6.29	330	2.3	1.21	516	3.5	1.89	286	2.0	1.05	962	6.6	3.52	2,074	14.2	7.60
1871, . . .	1,858	12.4	6.65	242	1.6	0.87	551	3.7	1.97	365	2.4	1.31	1,154	7.6	4.08	2,171	14.5	7.77
1872, . . .	2,295	15.0	6.55	363	2.4	1.04	543	3.5	1.55	376	2.5	1.07	1,202	7.8	3.43	2,771	18.1	7.91
1873, . . .	2,097	13.4	6.18	264	1.7	0.78	611	3.9	1.80	460	3.0	1.36	1,236	7.9	3.64	2,538	16.2	7.48
1874, . . .	2,386	14.9	7.48	449	2.8	1.41	585	3.6	1.82	463	2.9	1.45	1,272	7.9	3.99	2,418	15.0	7.57
1875, . . .	2,940	17.8	8.40	242	1.5	0.69	593	3.6	1.69	509	3.1	1.45	1,331	8.1	3.81	2,590	15.7	7.40
Totals and means,	32,868	12.2	6.25	6,014	2.2	1.14	8,219	3.0	1.56	4,062	1.5	0.77	17,550	6.6	3.34	36,054	13.4	6.86

TABLE 46. — STATISTICS OF CERTAIN CAUSES OF DEATH, MASSACHUSETTS, 1876-95 — *Concluded.*

Deaths, and Ratios compared with Population and Total Mortality — Concluded.

YEARS	PNEUMONIA.			WHOOPING COUGH.			CANCER.			KIDNEY DISEASES.			HEART DISEASES.			BRAIN DISEASES.		
	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.
1876, . . .	2,447	14.6	7.37	192	1.1	0.55	557	3.9	1.95	458	2.9	1.47	1,258	8.0	4.02	2,307	14.9	7.55
1877, . . .	1,972	11.6	6.29	369	2.2	1.18	546	3.8	2.06	535	3.1	1.71	1,355	8.0	4.32	2,521	14.8	8.04
1878, . . .	2,171	12.6	6.93	400	2.3	1.28	807	4.7	2.58	615	3.6	1.96	1,442	8.3	4.61	2,775	16.1	8.87
1879, . . .	2,647	15.1	8.32	302	1.7	0.95	862	4.9	2.71	693	3.9	2.18	1,515	8.6	4.76	2,820	16.1	8.87
1880, . . .	3,076	17.3	8.72	230	1.3	0.65	928	5.2	2.63	698	3.9	1.98	1,726	9.7	4.89	3,210	18.0	9.10
1881, . . .	2,967	16.4	8.14	217	1.2	0.59	949	5.2	2.60	825	4.5	2.26	1,937	10.7	5.31	3,355	18.5	9.20
1882, . . .	2,932	15.9	7.97	265	1.4	0.72	987	5.3	2.68	877	4.7	2.38	2,025	11.0	5.50	3,393	18.4	9.22
1883, . . .	3,045	16.2	8.07	137	0.7	0.36	1,026	5.5	2.72	959	5.1	2.54	2,153	11.5	5.70	3,562	19.0	9.44
1884, . . .	2,646	13.9	7.15	410	2.1	1.11	1,060	5.6	2.87	1,000	5.2	2.70	2,117	11.1	5.72	3,669	19.2	9.92
1885, . . .	3,468	17.9	9.10	184	0.9	0.48	1,067	5.5	2.80	1,088	5.6	2.86	2,227	11.5	5.85	3,894	20.0	10.22
1886, . . .	2,836	14.2	7.61	271	1.4	0.73	1,104	5.5	2.96	1,135	5.7	3.04	2,326	11.6	6.24	3,844	19.2	10.32
1887, . . .	3,348	16.3	8.21	232	1.1	0.57	1,174	5.7	2.88	1,120	5.4	2.75	2,690	13.1	6.60	4,257	20.7	10.44
1888, . . .	3,716	17.6	8.83	245	1.2	0.58	1,276	6.0	3.03	1,316	6.2	3.13	3,061	14.5	7.27	4,522	21.4	10.74
1889, . . .	3,440	15.6	8.23	310	1.4	0.74	1,326	6.1	3.17	1,258	5.8	3.01	3,280	15.1	7.85	4,313	19.8	10.32
1890, . . .	4,088	18.0	9.25	363	1.6	0.83	1,357	6.2	3.19	1,273	5.7	2.92	3,417	15.3	7.85	4,380	19.6	10.06
1891, . . .	4,337	18.9	9.60	219	1.0	0.48	1,395	6.1	3.09	1,474	6.4	3.26	3,592	15.7	7.93	4,711	20.6	10.43
1892, . . .	5,020	21.5	10.30	248	1.1	0.51	1,402	6.0	2.88	1,535	6.6	3.15	3,733	16.0	7.66	5,036	21.5	10.33
1893, . . .	5,400	23.0	11.20	274	1.1	0.56	1,533	6.4	3.12	1,685	7.0	3.43	3,511	14.7	7.15	5,144	21.5	10.46
1894, . . .	4,101	16.8	8.76	455	1.8	0.93	1,568	6.4	3.35	1,721	7.0	3.68	3,432	14.0	7.33	4,995	20.4	10.67
1895, . . .	4,652	18.6	9.79	269	1.1	0.57	1,749	7.0	3.68	1,860	7.4	3.91	3,566	14.8	7.50	5,062	20.2	10.65
Totals and means,	68,358	16.8	8.83	5,572	1.4	0.70	27,921	5.6	2.80	24,167	5.5	2.80	50,439	12.4	6.37	77,052	19.3	9.35

TABLE 47. — *Deaths and Death-rates from Certain Diseases and Groups of Diseases by Five-year Periods, 1856-95.*

Five year Periods.	Small-pox. Deaths.	Small-pox. Death-rate per 10,000 Living.	Measles. Deaths.	Measles. Death-rate per 10,000 Living.	Scarlet-fever. Deaths.	Scarlet-fever. Death-rate per 10,000 Living.	Diphtheria and Croup. Deaths.	Diphtheria and Croup. Death-rate per 10,000 Living.	Typhoid Fever. Deaths.	Typhoid Fever. Death-rate per 10,000 Living.	Dysentery. Deaths.	Dysentery. Death-rate per 10,000 Living.	Cholera Infantum. Deaths.	Cholera Infantum. Death-rate per 10,000 Living.	Consumption. Deaths.	Consumption. Death-rate per 10,000 Living.
1856-60, ...	764	1.3	910	1.5	6,235	10.5	2,949	4.9	4,740	8.0	3,450	5.8	3,815	6.4	23,161	38.9
1861-65, ...	579	.9	1,175	1.9	6,107	9.7	7,710	12.3	6,604	10.5	4,901	7.8	5,662	9.1	22,852	36.5
1866-70, ...	547	.8	1,061	1.6	4,670	6.8	3,664	5.3	5,490	8.0	3,244	4.7	6,948	10.1	23,061	33.4
1871-75, ...	2,052	2.6	1,133	1.4	6,782	8.6	5,038	6.4	6,431	8.2	2,191	2.8	12,453	15.8	27,204	34.6
1876-80, ...	102	.1	742	.9	3,517	4.1	13,676	15.8	3,893	4.5	2,386	2.7	9,054	10.5	26,835	31.0
1881-85, ...	119	.1	1,007	1.1	2,504	2.7	8,944	9.6	4,654	5.0	1,601	1.7	9,894	10.6	29,435	31.4
1886-90, ...	18	.02	1,089	1.0	1,810	1.7	8,857	8.4	4,391	4.1	1,276	1.2	10,904	10.3	28,868	27.3
1891-95, ...	46	.04	818	.7	2,857	2.4	7,652	6.4	3,826	3.2	1,063	.9	13,426	11.2	27,609	23.1

Deaths and Death-rates from Certain Diseases and Groups of Diseases by Five-year Periods, 1856-95 — Concluded.

Five-year Periods.	Child-birth. Deaths.	Child-birth. Death-rate per 10,000 Living.	Pneumonia. Deaths.	Pneumonia. Death-rate per 10,000 Living.	Whooping-cough. Deaths.	Whooping-cough. Death-rate per 10,000 Living.	Cancer. Deaths.	Cancer. Death-rate per 10,000 Living.	Kidney Diseases. Deaths.	Kidney Diseases. Death-rate per 10,000 Living.	Heart Diseases. Deaths.	Heart Diseases. Death-rate per 10,000 Living.	Brain Diseases. Deaths.	Brain Diseases. Death-rate per 10,000 Living.
1856-60, ...	1,222	2.0	5,727	9.6	1,419	2.4	1,389	2.3	261	.4	3,030	5.1	6,098	10.2
1861-65, ...	1,106	1.8	7,443	11.9	1,563	2.5	1,684	2.7	601	1.0	3,819	6.1	8,165	13.0
1866-70, ...	1,396	2.0	8,124	11.8	1,461	2.1	2,264	3.3	1,027	1.5	4,536	6.6	9,306	13.5
1871-75, ...	1,880	2.4	11,576	14.7	1,561	2.0	2,882	3.7	2,178	2.8	6,176	7.9	12,483	15.9
1876-80, ...	1,549	1.8	12,313	14.2	1,493	1.7	3,900	4.5	3,029	3.5	7,373	8.5	13,836	16.0
1881-85, ...	1,760	1.9	15,058	16.0	1,213	1.3	5,109	5.4	4,749	5.1	10,469	11.1	17,878	19.0
1886-90, ...	1,528	1.4	17,378	16.4	1,421	1.3	6,265	5.9	6,104	5.8	14,773	14.0	21,325	20.1
1891-95, ...	1,634	1.4	23,609	19.7	1,445	1.2	7,647	6.4	8,275	6.9	17,884	14.9	24,948	20.8

TABLE 48.—*Deaths from Each of Several Specified Causes, by Sexes, Months and at Different Periods of Life, during the Twenty Years 1856-75.*

	1856-75.	Small-pox.	Measles.	Scarlet-fever.	Diphtheria.	Croup.	Typhoid Fever.	Dysentery	Cholera Infantum	Consumption.	Pneumonia.
	Totals,	3,928	4,290	23,797	8,981	10,380	23,266	13,786	28,693	96,278	33,868
Sex.	Males,	2,367	2,229	11,900	4,214	5,466	12,177	6,890	15,291	43,314	17,095
	Females,	1,556	2,058	11,883	4,758	4,901	11,079	6,870	13,357	52,941	16,758
	Unknown,	5	3	14	9	13	10	26	45	23	15
Months.	January,	568	294	3,086	872	1,181	1,427	151	137	8,066	3,778
	February,	377	346	2,348	668	1,006	1,303	132	111	7,866	3,999
	March,	352	441	2,587	646	1,028	1,238	142	148	8,694	4,456
	April,	328	466	2,395	572	830	1,265	166	124	8,329	3,752
	May,	354	531	2,220	531	609	1,146	159	221	8,574	3,146
	June,	244	535	1,886	523	492	1,068	540	576	7,291	1,870
	July,	233	515	1,534	558	392	1,332	1,771	6,413	7,596	1,291
	August,	152	407	1,270	556	420	2,346	4,466	11,508	8,200	1,062
	September,	184	179	1,119	779	612	3,232	4,062	6,934	8,249	1,316
	October,	248	144	1,411	1,022	1,013	3,307	1,786	2,117	7,998	1,978
	November,	337	192	1,865	1,116	1,361	2,624	411	392	7,702	2,721
	December,	548	244	2,450	1,113	1,358	2,068	180	152	7,606	3,473
	Not stated,	3	5	8	5	2	23	13	8	62	11
Ages.	Under 5,	1,314	3,448	16,179	4,419	8,972	2,236	8,010	28,684	6,492	13,012
	5 to 10,	271	380	5,541	2,506	1,245	1,469	384	9	1,077	1,086
	10 to 15,	112	70	1,130	798	96	1,669	256	-	1,744	418
	15 to 20,	317	86	390	350	30	3,231	220	-	5,262	764
	20 to 30,	1,022	143	304	360	14	6,426	467	-	25,696	1,917
	30 to 40,	384	57	111	237	8	2,642	495	-	17,990	2,149
	40 to 50,	176	39	42	99	6	1,797	521	-	12,128	2,406
	50 to 60,	139	17	27	60	3	1,566	626	-	8,826	2,663
	60 to 70,	79	16	13	58	1	1,502	760	-	7,658	3,344
	70 to 80,	42	21	6	39	1	1,167	905	-	4,707	3,410
	Over 80,	26	3	5	6	1	421	665	-	1,063	1,665
	Not stated,	43	14	32	32	18	135	86	-	608	146

TABLE 49.— *Mean Annual Death-rate per 10,000 of the Living Population from Each of Several Specified Causes, Death-rate of Each Sex and at Different Periods of Life, with the Mortality by Months reduced to a Standard Mean of 100, for the Twenty Years 1856-75.*

	1856-75.	Small-pox.	Measles.	Scarlet-fever.	Diphtheria	Croup.	Typhoid Fever.	Dysentery.	Cholera Infantum.	Consumption.	Pneumonia.
	Totals,	1.46	1.59	8.82	3.33	3.85	8.62	5.11	10.71	35.70	12.19
SEX.	Males,	1.82	1.72	9.17	3.25	4.21	9.39	5.31	11.78	33.39	13.18
	Females,	1.11	1.48	8.49	3.40	3.50	7.91	4.91	9.68	37.82	11.26
MONTHS.	January,	170.4	80.6	133.0	114.4	134.0	77.3	11.2	5.2	98.7	135.5
	February,	124.1	104.1	127.6	99.1	125.2	66.8	12.4	5.0	103.0	157.0
	March,	105.6	120.9	128.1	84.8	116.7	67.8	12.1	6.0	106.4	159.7
	April,	101.7	132.0	122.5	77.5	97.3	66.2	14.7	7.7	105.3	139.0
	May,	106.2	145.5	110.9	69.7	79.4	58.0	16.2	9.0	104.9	112.8
	June,	75.6	151.5	96.5	70.9	57.7	55.8	30.0	24.4	92.2	69.3
	July,	69.9	141.1	75.9	73.2	44.5	70.0	151.4	261.6	92.8	46.3
	August,	45.6	111.5	62.9	72.9	47.7	120.8	381.7	469.6	100.3	38.8
	September,	57.0	50.7	57.3	105.6	71.8	169.1	357.9	292.2	104.3	48.8
	October,	74.4	39.5	69.9	134.1	115.2	192.8	152.6	86.8	97.8	70.9
	November,	104.5	54.4	95.4	151.3	158.4	147.8	86.3	16.5	97.4	100.8
	December,	164.4	66.9	121.3	146.0	153.5	104.6	16.2	6.2	96.2	124.5
AGES.	Under 5,	4.46	11.70	54.90	14.99	30.44	7.59	27.18	98.00	22.02	43.80
	5 to 10,	.99	1.38	20.19	9.13	4.54	5.35	3.22	.008	3.92	3.77
	10 to 15,	.43	.27	4.35	3.07	.37	6.43	.99	-	6.72	1.61
	15 to 20,	1.25	.34	1.54	1.42	.08	12.75	.87	-	32.61	3.01
	20 to 30,	2.06	.29	.61	.74	.03	10.93	.98	-	51.75	3.86
	30 to 40,	1.00	.15	.29	.62	.02	6.86	1.29	-	46.75	5.58
	40 to 50,	.62	.13	.15	.34	.02	6.25	1.81	-	42.21	8.37
	50 to 60,	.73	.09	.14	.31	.01	8.21	3.28	-	46.26	14.11
	60 to 70,	.67	.13	.10	.49	.01	12.69	6.42	-	64.97	28.35
	70 to 80,	.77	.38	.11	.71	.02	21.32	16.54	-	87.64	62.30
	Over 80,	1.52	.47	.17	.29	.06	24.68	32.53	-	62.32	97.69

TABLE 50.—*Mortality from Each of Several Specified Causes, by Ages, Months and at Different Periods of Life, during the Twenty Years 1876–95.*

1876–95.		Small-pox.	Measles.	Scarlet-fever.	Diphtheria.	Croup.	Typhoid Fever.	Dysentery.	Cholera Infantum.	Consumption.	Pneumonia.
Totals,		282	3,653	10,688	29,318	9,811	16,764	6,326	43,278	112,537	68,358
SEX.	Males,	151	1,786	5,242	14,236	5,234	9,007	2,913	23,116	51,519	34,646
	Females,	131	1,866	5,445	15,080	4,577	7,756	3,413	20,156	61,016	33,711
	Unknown,	–	1	1	2	–	1	–	6	2	1
MONTHS.	January,	24	294	1,290	2,664	1,190	1,127	96	190	10,044	9,946
	February,	31	292	1,000	2,406	935	673	95	186	9,100	8,129
	March,	29	360	1,171	2,225	972	919	106	196	10,482	9,216
	April,	40	500	1,066	2,177	796	932	103	215	10,234	8,674
	May,	47	567	1,089	2,298	630	894	127	245	10,116	6,676
	June,	19	507	807	2,017	447	782	153	1,408	8,770	3,409
	July,	7	309	580	1,700	310	920	1,009	14,068	8,977	2,282
	August,	1	171	508	1,688	389	1,775	2,236	16,302	9,022	1,860
	September,	8	101	480	2,078	564	2,627	1,468	7,685	8,877	2,217
	October,	11	94	715	2,112	1,049	2,579	620	2,063	9,179	3,508
	November,	24	149	924	2,244	1,255	1,878	192	457	8,696	4,940
	December,	31	219	1,040	3,337	1,324	1,458	101	201	9,340	7,441
AGES.	Under 5,	101	2,026	6,802	16,916	8,162	868	2,831	43,257	5,061	19,254
	5 to 10,	23	308	2,759	8,661	1,407	870	308	7	1,004	1,718
	10 to 15,	11	65	545	2,032	73	1,162	71	–	2,096	693
	15 to 20,	27	56	184	544	15	2,568	75	–	10,892	1,546
	20 to 30,	68	86	199	511	10	5,097	230	–	24,649	4,584
	30 to 40,	26	39	67	239	14	2,357	224	–	23,478	5,616
	40 to 50,	11	19	10	147	6	1,823	292	–	14,244	6,412
	50 to 60,	4	16	4	96	6	899	402	–	9,279	7,013
	60 to 70,	1	12	5	77	4	773	667	–	6,941	8,527
	70 to 80,	1	13	2	38	1	595	847	–	4,095	8,197
	Over 80,	1	6	–	12	1	189	665	–	927	4,812
	Not stated,	8	10	21	47	14	23	18	14	248	129

TABLE 51.—*Mean Annual Death-rate per 10,000 of the Living Population from Each of Several Specified Causes, Death-rate of Each Sex and at Different Periods of Life, with the Mortality by Months reduced to a Standard Mean of 100, for the Twenty Years 1876-95*

	1876-95.	Small-pox.	Measles.	Scarlet-fever.	Diphtheria.	Croup.	Typhoid Fever.	Dysentery.	Cholera Infantum.	Consumption.	Pneumonia.
	Totals,	.07	.90	2.63	7.22	2.42	4.13	1.56	10.66	27.80	16.84
SEX.	Males,	.08	.91	2.68	7.27	2.67	4.60	1.49	11.80	26.45	17.68
	Females,	.06	.89	2.59	7.18	2.18	3.69	1.63	9.60	29.06	16.05
MONTHS.	January,	142.1	94.8	143.2	124.0	142.9	79.2	17.9	5.2	104.9	171.4
	February,	142.2	103.4	121.0	106.1	123.2	67.3	19.4	4.7	104.2	153.8
	March,	121.2	116.1	129.1	89.4	116.8	64.6	19.7	5.8	109.5	158.8
	April,	172.7	166.7	121.5	90.4	98.8	67.7	19.8	6.0	110.4	154.5
	May,	196.4	182.9	120.1	92.4	75.6	62.8	23.7	9.4	105.6	115.1
	June,	82.0	169.0	91.9	83.7	55.5	56.8	35.2	39.5	94.6	60.7
	July,	29.2	128.7	63.9	68.3	37.2	64.7	187.9	382.8	93.7	39.0
	August,	49.7	55.2	56.0	65.8	40.7	125.0	416.5	443.5	94.2	32.1
	September,	34.5	33.7	55.7	86.3	70.0	190.8	282.5	216.2	95.8	39.5
	October,	46.0	30.3	78.8	125.1	126.0	181.3	115.5	56.2	96.8	61.8
	November,	103.6	49.7	105.3	134.7	155.8	136.4	35.0	12.9	93.8	88.0
	December,	129.5	70.6	114.7	134.1	159.0	102.3	18.8	5.5	97.5	128.2
AGES.	Under 5,	.27	8.08	18.41	45.19	21.81	2.29	6.76	115.58	18.52	51.47
	5 to 10,	.06	.84	7.54	23.66	4.12	2.38	.83	.02	2.74	4.69
	10 to 15,	.03	.18	1.54	5.75	.21	3.34	.20	-	5.93	1.96
	15 to 20,	.07	.15	.48	1.43	.04	6.82	.20	-	28.69	4.12
	20 to 30,	.08	.11	.25	.64	.01	6.40	.29	-	43.41	5.76
	30 to 40,	.04	.06	.11	.40	.02	3.96	.38	-	39.43	9.43
	40 to 50,	.02	.04	.02	.32	.01	2.92	.64	-	31.44	14.15
	50 to 60,	.01	.05	.01	.30	.01	2.83	1.26	-	29.19	22.06
	60 to 70,	.005	.06	.02	.38	.02	3.77	3.25	-	33.97	41.65
	70 to 80,	.01	.13	.02	.38	.01	5.97	8.50	-	41.10	82.27
	Over 80,	.03	.19	-	.38	.03	6.04	21.26	-	29.63	148.07

Summary of Certain Special Causes of Death presented in the Foregoing Tables.

For the sake of uniformity the same order will be observed in this discussion as that which was adopted in the reports of the Board for the last two years, with the addition of dysentery and child-birth. The terms "first and second period" or "first and last period" refer in each instance to the two twenty-year periods 1856–75 and 1876–95, unless otherwise specified. The term "death-rate" in this discussion of causes of death means the ratio of deaths per 10,000 of the living population, unless otherwise specified. When the term "general death-rate" is employed it means the death-rate from all causes, and is reckoned as a ratio per 1,000 of the living population. (For a full discussion of the mortality from measles, scarlet-fever, diphtheria and croup, small-pox, typhoid fever, cholera infantum, phthisis and pneumonia, with reference to their geographical distribution, with maps, see twenty-third annual report of the Board, 1891, pages 759–874.)

Small-pox.

Total deaths, 1856–95, 4,225.

During the seventeenth and eighteenth centuries epidemics of small-pox were of very frequent occurrence in Massachusetts, as historical records present abundant proof. Some of the most noted of these were those of 1631, 1633, 1639, 1677, 1678, 1702, 1721 (in this year nearly 8 per cent. of the whole population of Boston died of small-pox), 1730, 1752, 1764, 1776, 1778 and 1792.

From the date of the introduction of vaccination down to 1840 the mortality from small-pox was extremely small. Records are incomplete for these years, but from all that can be learned it is probable that the total mortality from this cause did not exceed 200 deaths in the State during these forty years. Unfortunately, the vaccination law was modified in 1836 and made less stringent, and the deaths from small-pox soon increased, the number in Boston alone in the three years 1839–41 amounting to 232. After that date the enactment of the registration laws furnished accurate returns for the whole State, and from these it appears that the deaths from this cause from 1842 to 1855 inclusive were 1,304.

No deaths were registered from this cause in 1895 and there were none in 1886.

Of all the causes of death mentioned in the foregoing tables small-pox was the most irregular in its influence on the death-rate, the figures varying from 0 in 1886 and 1895 to 6.7 per 10,000 of the

population in 1872. The mean annual small-pox death-rate of the first twenty years was 1.5 per 10,000 living, and that of the last twenty years was only .07 per 10,000.

The slight discrepancy between the total numbers of deaths from small-pox in tables 46, 48 and 50 is due to the inclusion, in the former table, of 15 deaths registered as due to chicken-pox which are not included in the latter table. It is quite probable that deaths registered as from chicken-pox are those of persons who have died of small-pox, especially when occurring in years of small-pox epidemics.

More than 40 per cent. of the deaths from small-pox which occurred in the forty years 1856–95 were those of the epidemic of 1872 and 1873.

Sex. — The death-rate of males was considerably greater than that of females, being in the ratio of 164 males to 100 females in equal numbers living in the first period, and as 133 males to 100 females in the second period.

Seasonal Mortality. — The deaths from small-pox in the first period of twenty years were most numerous in January and December, and least numerous in August and September. In the second period they were the greatest in number in April and May, and least in July and August.

Ages. — In Table 49 it appears that the greatest small-pox death-rate occurs at the age period 0 to 5 years and the least at the period 10 to 15. A considerable increase occurs at the ages 15 to 40, undoubtedly due to the neglect of revaccination at an age when the protective power of primary vaccination has considerably diminished. (A further discussion upon the mortality from small-pox in Massachusetts, with special reference to the influence of vaccination, may be found in the twenty-sixth annual report of the Board, 1894, pages viii–xxiii.)

Measles.

Deaths, 1856-95, 7,952.

The deaths from measles in 1895 were 117, and the death-rate was .5 per 10,000 of the living population, which was less than the mean of the twenty-year period 1876–95. Comparing the two twenty-year periods, 1856–75 and 1876–95, a decided lessening in the mortality from this cause is evident, that of the former period being 1.6 per 10,000 living and that of the latter .9, or but little more than one-half as great. The total number of deaths from this cause in the former period was 4,299 and in the latter 3,653.

At no time in the first twenty years did the deaths from this cause fall below 100 in a single year, while in the latter period there were six years in which the deaths from measles were as follows: 47, 19, 68, 75, 88 and 98.

The deaths of females were as 100 to 116 males in equal numbers living in the first twenty-year period, and as 100 females to 102 males in the second period.

Seasonal Prevalence.—It appears that in the first period the greatest mortality from this cause occurred in June, and in the second period in May, and the least in October in each period. The second period showed greater departures from the mean than the first period.

Age.—The death-rates from measles at different ages of life are presented in tables 49 and 51. They show marked improvements at all ages of life. The death-rate of children under five was 11.7 per 10,000 in the first period and 8.08 in the second.

A statement of the death-rate* of children at each of the first five years may be found in the report of 1894, page xc, wherein it appears that the greatest death-rate from this cause occurs at age one to two years. A statement of the geographical distribution of measles, with the mortality of each city and town from this cause, may be found in the twenty-third report of the Board (1891), page 780. The highest mortality from this cause was shown to exist in Suffolk County and the lowest in Nantucket.

Scarlet-fever.

Total deaths, 1856-95, 34,485.

The deaths from scarlet-fever in 1895 were 483. This number was less than that of either of the three preceding years, but greater than that of 1889, 1890 or 1891. The deaths from this cause in the first period were 23,797 and those of the second period were 10,688. The mean annual death-rates were, respectively, 8.8 and 2.6 per 10,000 living. In only three years of the first period did the death-rate per 10,000 from this cause fall below 6, while in the second period it exceeded that rate in only one year, and that was 1876, the first year of the period.

Had the same death-rate from scarlet-fever prevailed in the second period, 1876–95, as prevailed in the first period the mortality from scarlet-fever would have amounted to 25,000 more than act-

* The term "death-rate" as here used should not be confounded with "fatality," *i. e.*, the ratio of deaths to cases.

ually occurred in those years, and this number may be taken as the actual saving of life from this cause.

Sex.—The deaths of males to females were as 108 to 100 in equal numbers living in the first period, and as 103 to 100 in the second period.

Seasonal Mortality.—The greatest mortality from scarlet-fever in each period was in January and the least in September.

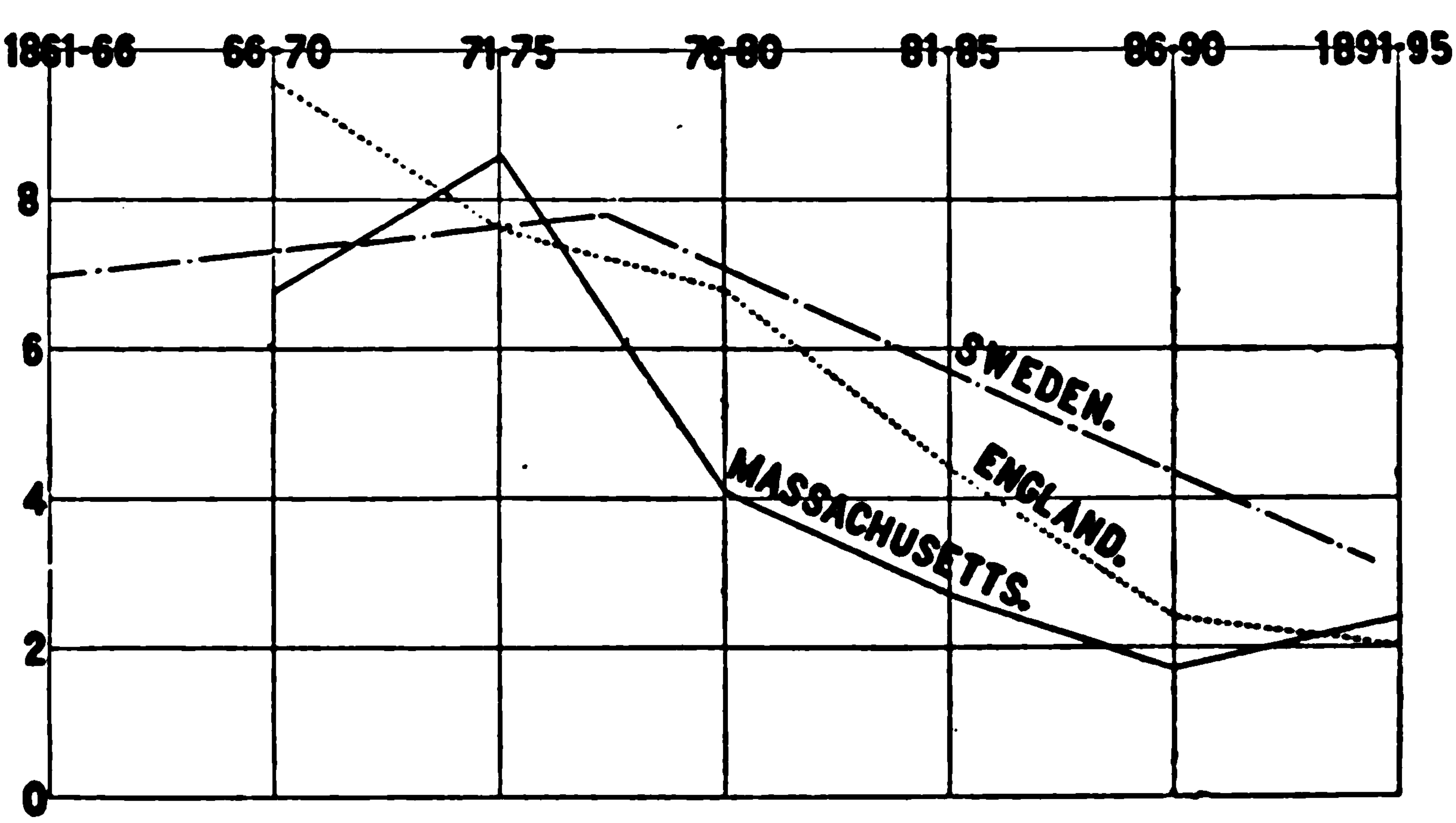
Age.—The death-rate at different ages shows a rapid decrease from the infantile period (0–5) to the age of 60 years; the highest death-rate at age 0–5 was 54.9 per 10,000 living of those ages in the first period, that of the same age in the second period being 18.41, or about one-third as great.

The death-rate* of children at each of the first years of life from this cause (corrected) may be found in the report of 1894, page xc, wherein it appears that the greatest death-rate from scarlet-fever occurs in the third and fourth years of life.

The marked improvement in the death-rate from this disease since 1856 is shown by the following death-rates of five-year periods:—

TABLE 52.—*Death-rates from Scarlet-fever, 1856–95.*

Period.	Death-rate.	Period.	Death-rate.
1856–60, ...	10.5	1876–80, ...	4.1
1861-65, ...	9.7	1881-85, ...	2.7
1866-70, ...	6.8	1886-90, ...	1.7
1871-75, ...	8.6	1891-95, ...	2.4



DEATH-RATE PER 10,000 FROM SCARLET-FEVER. DECLINE IN DIFFERENT POPULATIONS.

* See note on page 774.

That the diminution in the death-rate of scarlet-fever indicated by the foregoing figures is not peculiar to Massachusetts may be shown by an examination of the vital statistics of other countries. The following table presents the same data for certain European countries, together with those of Massachusetts for similar periods: —

TABLE 53. — *Decrease in Scarlet-fever in Different Countries.*

Death-rates per 10,000 Living at Certain Periods.

	1866-70.	1871-75.	1876-80.	1881-85.	1886-90.	1891-94.
England,	9.6	7.6	6.8	4.4	2.4	2.0
Ireland,	5.5	5.5	3.2	2.7	1.4	1.0
Scotland,	10.9	10.6	5.3	3.5	2.2	2.0
Massachusetts,	6.8	8.6	4.1	2.7	1.7	2.5

COUNTRIES.	1861-70.	1871-80.	1881-90.	1891-94.
Sweden,	6.99	7.8	5.04	3.12
Norway,	3.06*	5.15	3.55	1.13†
	1865-74.	1875-84.	1885-94.	
Denmark,	6.2	3.8	1.4	-
	1877-84.	1885-89.	1890-94.	
Germany,	4.8	2.7	1.8	-

* 1862-70. † 1891-95.

Cities.

CITIES.	1879-86.	1888-94.	CITIES.	1879-86.	1888-94.
Budapest,	45	33	Amsterdam,	30	3
Vienna,	25	18	Venice,	4	3
Prague,	54	35	Turin,	10	8
Trieste,	22	24	Rome,	14	4
Hague,	16	10	Brussels,	8	2
Rotterdam,	30	14	Paris,	10	8

The foregoing data are to be found in a paper entitled "A Contribution to the Natural History of Scarlet-fever," by John T. Wilson, M.D., D.Ph., Medical Officer of Health, Lanarkshire, Scotland.

An examination of the reports of health officers of the Australian colonies and New Zealand shows that similar changes in the death-rate from scarlet-fever are also taking place there.

Diphtheria and Croup.

Total deaths, 1856-95, 58,490.

In Table 46 the deaths registered under these terms are considered together.

In 1895 the deaths registered from these causes were 1,784, of which number 1,432 were certified as deaths from diphtheria and 352 as deaths from croup. The death-rate per 10,000 from these combined causes was 7.1, that of 1894 having been 7.4.

The total deaths recorded from these causes in the first twenty-year period were 19,361, and the death-rate 7.2 per 10,000, and those in the last period were 39,129, and the death-rate 9.6 per 10,000.

Dividing the last period into five-year groups there appears to have been a marked diminution, as shown by the following death-rates for the respective periods: —

1876-80,	15.8
1881-85,	9.5
1886-90,	8.4
1891-95,	6.4

The term "diphtheria" does not appear in the records of deaths until 1858, in which year 18 deaths were registered from this cause. There were 32 in 1859, 258 in 1860, increasing rapidly to 1,420 in 1863, and then decreasing until there were less than 300 in each of the six years 1867-72. It then increased rapidly until 1876 and 1877, when it became seriously epidemic in many parts of the State, the deaths from this cause in the two years amounting to 5,244.

While the disease did not appear under the name of diphtheria in the two previous centuries in Massachusetts it is believed that it often prevailed to a serious extent, so far as the limited descriptions of early medical practitioners may be trusted.

Sex. — The death-rate of males from these combined causes was 7.46 per 10,000 and that of females 6.90 in the first period, or in the ratio of 108 males to 100 females in equal numbers living. In the second period the death-rates were 9.94 for males and 9.36 for females, or 106 males to 100 females in equal numbers living.

If the deaths from the two causes are separated, it appears that the death-rate of males from diphtheria in the first period was slightly less than that of females, while the death-rate of males from croup considerably exceeded that of females. In the second period the death-rate of males was higher both from diphtheria and croup.

Seasonal Prevalence. — The monthly mortality from these two diseases exhibits a striking similarity, both when the two diseases are compared and for the two twenty-year periods. The greatest prevalence in each period and in each disease occurred in the months of November and December, and the least usually in July and August, but the table for diphtheria in the period 1856–75 shows a slightly lower figure in May and June.

During the last two years the demands for antitoxin and for the examination of throat cultures received at the office of the State Board of Health from local boards furnish quite a reliable index of the seasonal prevalence of this disease, or group of diseases, as well as the returns furnished under the act relating to the notification of diseases.

Age. — The death-rate * at the age period 0–5 is much the highest, rapidly diminishing to the later ages of life. Considering the two causes separately the difference in mortality between the early ages is much greater in the case of croup than it is in diphtheria. The following figures from the twenty-sixth annual report show that the highest death-rate from diphtheria occurred in the third year of life and that of croup occurred in the second year, though the difference in the latter case between the mortality of the second and third years was slight.

The figures for each year were as follows: —

TABLE 54. — *Death-rate per 10,000 at Early Ages (1887–93).*

	Diphtheria.	Croup.		Diphtheria.	Croup.
0–1 years, . . .	12.4	13.2	3-4 years, . .	37.8	13.5
1–2 years, . . .	32.3	19.5	4–5 years, . .	32.9	9.2
2–3 years, . . .	38.7	19.2			

For a full discussion of the mortality from diphtheria during the period 1871–80 see summary by Dr. C. F. Folsom in thirty-ninth Massachusetts registration report, 1880, pages 80–110.

* See note on page 774.

Typhoid Fever.

Total deaths, 1856-95, 40,029.

The deaths from typhoid fever in 1895 were 680, and this number was, with the exception of the deaths in 1878 and 1879, the least number registered from this cause in the forty years 1856–95. The death-rate in 1895 from this cause was 2.7 per 10,000, this being the lowest death-rate on record for the whole State during the forty-year period, the highest having been 13.4 in 1865. From 1872 down to 1895 the decrease in the death-rate from typhoid fever has been comparatively uniform, the chief exceptions being the years 1880 and 1881, when the death-rate from this cause rose from 3.6 per 10,000 to 4.9 and 5.9.

The total deaths from this cause in the first twenty-year period were 23,265 and the death-rate was 8.6 per 10,000; while those of the second twenty years were 16,764 and the death-rate was 4.1 per 10,000.

It is interesting to note the decline in the typhoid fever death-rate in its general coincidence with the introduction of public water supplies throughout the State, a fact which is shown in the accompanying table and diagram.

TABLE 55.— *Table showing the Proportion of the Population of the State of Massachusetts living in Cities and Towns having Public Water Supplies.*

YEAR.	Number of Towns having a Public Water Supply.	Population of Towns having a Public Water Supply.	Number of Towns not having a Public Water Supply.	Population of Towns not having a Public Water Supply.	Per Cent. of Population served with Public Water Supplies.	Per Cent. of Population not Supplied.
1850, . . .	8*	196,122	314*	798,392	19.73	80.27
1851, . . .	8	205,089	315	817,046	20.06	79.94
1852, . . .	8	213,956	318	835,700	20.38	79.62
1853, . . .	8	222,873	321	854,354	20.69	79.31
1854, . . .	8	231,790	321	873,008	20.98	79.02
1855, . . .	10	240,706	322	891,661	21.25	78.75
1856, . . .	11	267,517	321	884,591	23.22	76.78
1857, . . .	11	273,857	321	897,990	23.37	76.63
1858, . . .	11	280,200	321	911,386	23.51	76.49
1859, . . .	12	289,138	320	922,188	23.87	76.13
1860, . . .	12	295,500	320	935,566	24.00	76.00
1861, . . .	13	307,411	319	930,848	24.82	75.18

* The number of municipalities had increased between 1850 and 1896, by subdivision, from 322 to 353.

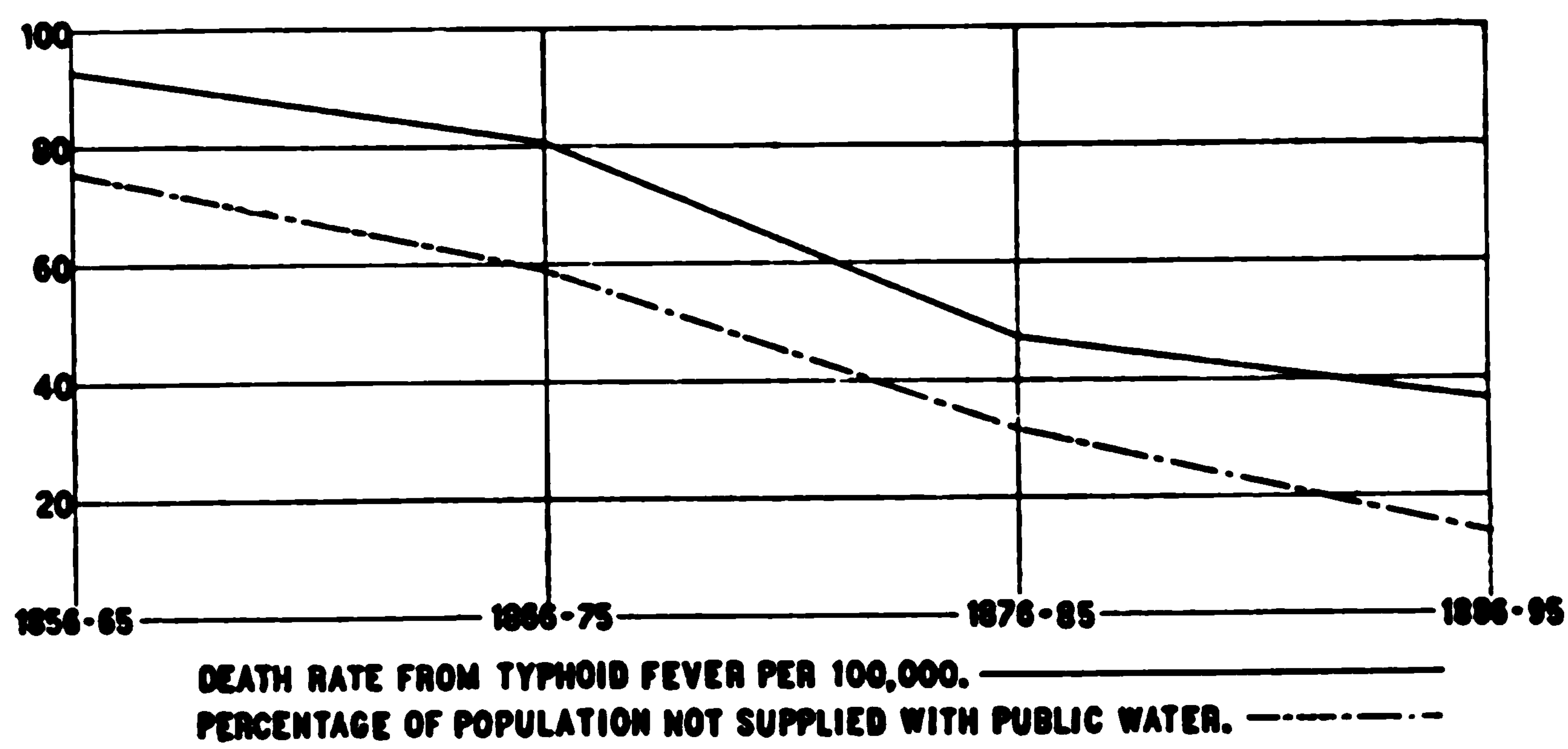
TABLE 55 — *Concluded.*

YEAR.	Number of Towns having a Public Water Supply.	Population of Towns having a Public Water Supply.	Number of Towns not having a Public Water Supply.	Population of Towns not having a Public Water Supply.	Per Cent. of Population served with Public Water Supplies.	Per Cent. of Population not Supplied.
1862, . . .	14	314,467	318	930,965	25.25	74.75
1863, . . .	14	319,422	318	933,223	25.50	74.50
1864, . . .	14	324,279	320	935,550	25.74	74.26
1865, . . .	14	329,335	320	937,696	25.99	74.01
1866, . . .	14	348,442	321	956,653	26.70	73.30
1867, . . .	18	401,014	317	942,145	29.86	70.14
1868, . . .	19	428,508	316	952,715	31.02	68.98
1869, . . .	20	471,065	315	948,222	33.19	66.81
1870, . . .	26	518,371	310	938,980	35.57	64.43
1871, . . .	28	585,806	310	910,455	39.15	60.85
1872, . . .	32	677,528	306	857,647	44.13	55.87
1873, . . .	41	763,515	297	810,572	48.51	51.49
1874, . . .	46	884,146	294	728,853	54.82	45.18
1875, . . .	52	979,579	288	672,833	59.30	40.70
1876, . . .	57	1,044,984	284	633,162	62.27	37.73
1877, . . .	58	1,067,275	286	637,105	62.62	37.38
1878, . . .	62	1,094,266	280	636,349	63.24	36.76
1879, . . .	64	1,123,319	280	633,531	63.94	36.06
1880, . . .	66	1,172,971	276	610,114	65.79	34.21
1881, . . .	73	1,239,651	272	575,245	68.31	31.69
1882, . . .	77	1,284,071	269	562,636	69.53	30.47
1883, . . .	82	1,345,850	264	532,668	71.64	28.36
1884, . . .	91	1,411,352	255	498,977	73.88	26.12
1885, . . .	106	1,528,459	240	413,682	78.70	21.30
1886, . . .	114	1,614,831	234	386,670	80.68	19.32
1887, . . .	121	1,701,079	227	359,782	82.54	17.46
1888, . . .	127	1,775,694	221	344,527	83.76	16.24
1889, . . .	132	1,850,305	219	329,277	84.89	15.11
1890, . . .	137	1,924,812	214	314,131	85.97	14.03
1891, . . .	142	1,989,937	209	301,254	86.86	13.14
1892, . . .	143	2,042,879	208	300,560	87.17	12.83
1893, . . .	146	2,104,805	205	290,882	87.86	12.14
1894, . . .	149	2,167,914	203	280,021	88.56	11.44
1895, . . .	154	2,237,017	198	263,166	89.48	10.52
1896, . . .	159*	2,300,925	194*	251,506	90.14	9.86

* The number of municipalities had increased between 1850 and 1896, by subdivision, from 332 to 353.

Summary by Decades, 1856-95.

Period.	Death-rate from Typhoid Fever per 100,000.	Percentage of Population not Supplied with Public Water.	Period.	Death-rate from Typhoid Fever per 100,000.	Percentage of Population not Supplied with Public Water.
1856-65, . . .	92.9	75.44	1876-85, . . .	47.4	31.75
1866-75, . . .	80.8	58.94	1886-95, . . .	36.4	13.93



The death-rate from this cause has generally fallen as the per cent. of the population supplied with public water has risen, for the reason that the majority of the deaths from typhoid fever have occurred among communities and portions of communities *not supplied with public water*. Hence, in the foregoing diagram, this percentage of the population (*not supplied with public water*) is compared with the death-rate from typhoid fever. The method of representation (by ten-year periods) presents a much more uniform showing than that by single years.

In 1856 there were only 11 cities and towns supplied with public water, and the population thus supplied in that year was only 23.2 per cent. of the total population. (In 1850 it was only 19.7 per cent.) In 1870 this percentage had only increased to 35.6, but during the succeeding decade the percentage thus supplied had nearly doubled, being 65.8 in 1880. From that time onward the increase has been quite uniform but less rapid, and amounted in 1896 to 90.1 per cent. of the total population.

It will be seen by the diagram and table that the decrease in the typhoid death-rate from the mean of the decade 1865–75 to the

mean of the decade 1876–85 was also considerably more rapid than that of either the preceding or the succeeding periods.

The death-rates by five-year periods were as follows: 8.0, 10.5, 8.0, 8.2, 4.5, 5.0, 4.1, 3.2.

Seasonal Prevalence. — The two tables indicating seasonal prevalence (pages 769 and 771) show in each a uniform course below the yearly mean from January to July, then increasing rapidly to October in the first period and to September in the second, and then diminishing with nearly the same rapidity to January.

Sex. — The death-rate of males was in each period considerably greater than that of females, the rates in the first period being 9.4 for males and 7.9 for females, or in the ratio of 119 males to each 100 females in equal numbers living, and in the second period 4.6 for males and 3.7 for females, or as 125 males to 100 females.

Ages. — The highest death-rate in the first period appears to have occurred at ages from fifteen to thirty years and among all persons over sixty, those of ages above seventy considerably exceeding all others. In the second period the death-rate at ages fifteen to thirty is greatest but is nearly equalled by that of ages over seventy years. The greatest improvement, comparing the same ages in the two twenty-year periods, appears to have taken place at all ages over fifty years. (Further information relative to the mortality from typhoid fever in Massachusetts may be found in the second report of the State Board of Health, 1871, in a paper by Dr. George Derby.)

Dysentery.

Total deaths, 1856–95, 20,112.

In 1895 the deaths from dysentery numbered 209, and with the exception of those in 1892, which were 193, were the least in number during the whole forty-year period. The death-rate from this cause was only .8 per 10,000 living.

The total number of deaths registered from this cause in the forty years was 20,112, of which 13,786 occurred in the first half and 6,326 in the last half of the period, and the death-rates were respectively 5.1 and 1.6.

The decline in the death-rate from this disease is continuous and well marked. The deaths from this cause in the ten years ending with 1866 were 8,351, while those in the ten years ending with 1895 were only 2,359, the population, meanwhile, having doubled. The

deaths from this cause in the latter period as compared with those in the former were approximately in the ratio of 100 to 658, in equal numbers living. In those early years of the first period, as many practitioners will remember, dysentery was an epidemic disease of the summer months, prevailing to a greater or less degree in almost every city and town in the State, great and small, but within the past twenty years it appears to have very largely lost its epidemic character, its incidence upon the population being comparatively small. Its continuous and comparatively uniform decline points to its possible extinction at no distant period as a factor in the death-rate.

Seasonal Prevalence. — The monthly distribution of dysentery shows that its mortality by months was nearly identical in the two twenty-year periods, remaining at a low figure for the first five months and then rising slightly in June, and then very rapidly to a climax in August, and descending in like manner to November. (See pages 769 and 771.)

Sex. — The death-rate of males in the first period was 5.3 and that of females 4.9, or as 108 deaths of males to 100 deaths of females in equal numbers living. In the second period the conditions were reversed, the deaths of males being 1.49 and that of females 1.63, or in the ratio of 100 males to 109 females in equal numbers living. (See pages 769 and 771.)

Ages. — The death-rate was in both periods highest at the extreme ages of life, that of old age (80+) being the highest in both periods. The greatest relative improvement appears to have taken place at the age periods 0 to 5 and 5 to 10.

Cholera Infantum.

Total deaths, 1856–95, 72,191.

In the following summary are included only those deaths which were registered as from cholera infantum. The addition of all deaths from diarrhœal diseases of infants under one year, including those from enteritis, would increase the number by from 25 to 30 per cent.

The deaths from cholera infantum in 1895 were 2,377, and the death-rate 9.5 per 10,000 of the living population.

The total number of deaths from this cause in the forty years ending with 1895 was 72,191, of which 28,893 occurred in the first period and 43,278 in the second. The death-rates from this cause in the two periods were nearly equal, being in the ratio of 10.71 per 10,000 in the first period and 10.66 in the second.

The death-rates of the successive five-year periods were as follows: 6.4, 9.1, 10.1, 15.8, 10.5, 10.5, 10.3, 11.2.

Seasonal Prevalence. — The seasonal mortality of this disease follows very nearly in the same track with dysentery, but with greater departures from the mean annual mortality, the deaths during the eight months from November to June inclusive amounting to less than 7 per cent. of the number for the whole year.

Sex. — The death-rates of the sexes were as follows for the two periods. In the first the death-rate of boys was 11.8 and that of girls 9.7 per 10,000 living, and in the second period 11.8 and 9.6 respectively, or as 100 deaths of girls to 122 of boys in the first and as 100 deaths of girls to 123 of boys in the second period in equal numbers living. (See pages 769 and 771.)

Ages. — The deaths being almost entirely in the first age period of life (0–5 years), a greater difference appears here than in the general death-rate, since the birth-rate, which largely influences the numbers living at the first age (0–5), was considerably greater in the first period than in the second, the death-rate of children under five from cholera infantum being 98 per 10,000 in the first and 115.6 in the second period.

Diarrhœal Diseases.

Total number of deaths in this group, 1856-95, 131,387.

Under this title are included the deaths from cholera infantum, dysentery, diarrhœa, cholera morbus and enteritis.

Two of the principal factors in this group, cholera infantum and dysentery, have already been considered.

The total number of deaths from this group in each twenty-year period with the death-rates were as follows: —

TABLE 56. — *Deaths from Diarrhœal Diseases, 1856-95.*

Period.	Deaths.						Death-rates per 10,000.					
	Cholera Infantum.	Dysentery.	Diarrhœa.	Cholera Morbus.	Enteritis.	Total.	Cholera Infantum.	Dysentery.	Diarrhœa.	Cholera Morbus.	Enteritis.	Total.
1856-75,	28,893	13,786	6,934	1,891	5,422	56,926	10.71	5.11	2.57	.70	2.01	21.11
1876-95,	43,278	6,326	9,971	1,756	13,130	74,461	10.66	1.55	2.46	.43	3.22	18.34
Aggregates,	72,171	20,112	16,905	3,647	18,552	131,387	10.69	2.98	2.50	.54	2.74	19.46

There was, therefore (comparing the two periods), a slight decrease in the death-rate from cholera infantum, a very great decrease in that of dysentery (5.11 to 1.55), a slight decrease in that of diarrhœa (2.57 to 2.46), a considerable decrease in that of cholera morbus (0.70 to 0.43), and a marked increase in that of enteritis (2.01 to 3.23). There was, therefore, a gain, comparing the two twenty-year periods, of 2.77 per 10,000 of the population in the total of these diseases.

Whooping-cough.

Total deaths, 1856-95, 11,586.

The deaths from whooping-cough in 1895 were 269, and the death-rate per 10,000 was 1.1. During the years 1892 and 1893 it was also 1.1, and 1.8 in 1894.

The deaths from this cause in the whole forty-year period were 11,586, of which 6,014 occurred in the first twenty years and 5,572 in the last twenty years, the death-rates of the two periods being 2.2 for the first and 1.4 for the second. The maximum and minimum years of prevalence were 1861, with a death-rate of 3.3 in the first period, and 1883, with 0.7 in the second.

Ages.—In the twenty-sixth report, page xc, it was shown that while measles, scarlet-fever, diphtheria and croup are most destructive to life in the second and third years, whooping-cough destroys greater numbers in the first year of life, the death-rate at that age being nearly three times as great as during the second year. The death-rates for the first ten years (corrected) were as follows:—

Years.	Death-rate from Whooping-cough.	Years.	Death-rate from Whooping-cough.
0-1, ...	33.7	3-4, ...	3.0
1-2, ...	12.7	4-5, ...	1.4
2-3, ...	5.1	5-10, ...	0.4

*Consumption.**

Total deaths, 1856-95, 209,115.

In the report of the Board for 1894 (page lxxv) consumption was treated with greater fulness of detail than other diseases, in conse-

* In this summary the term "consumption" refers only to *phthisis pulmonalis*, or *consumption of the Lungs*, except where otherwise stated.

quence, mainly, of the manifest interest in the subject everywhere prevailing. The demand for such information continues, and hence a more minute analysis of the statistics of the mortality from this cause will be presented in this summary. The recent publication by the Board of Dr. Russell's pamphlet on "The Prevention of Tuberculosis" has also increased the public interest in all that pertains to the question.

The number of deaths registered as from consumption in 1895 was 5,486, and the death-rate was 21.9 per 10,000, being the lowest death-rate from this cause yet recorded for the State.

The whole number of deaths registered from consumption in the forty years 1856–95 was 209,115, and the mean death-rate of the whole period from this cause was 30.9 per 10,000 living.

Of the whole number of deaths, 96,278 occurred in the first twenty years and 112,837 in the last twenty, the mean death-rate of each period being, respectively, 35.7 and 27.8 per 10,000. The maximum death-rate in any year from this cause was that of the first year, 1856, and was 40.8 per 10,000, and the minimum (21.9) was that of the last year, 1895, so that the death-rate from consumption had declined nearly one-half in the whole period of forty years.

Sex. — The deaths of males from consumption were 43,314 in the first period and 51,819 in the second, and those of females were 52,941 in the first and 61,016 in the second. The number of persons whose sex was not stated, in the whole period of forty years, was only 25.

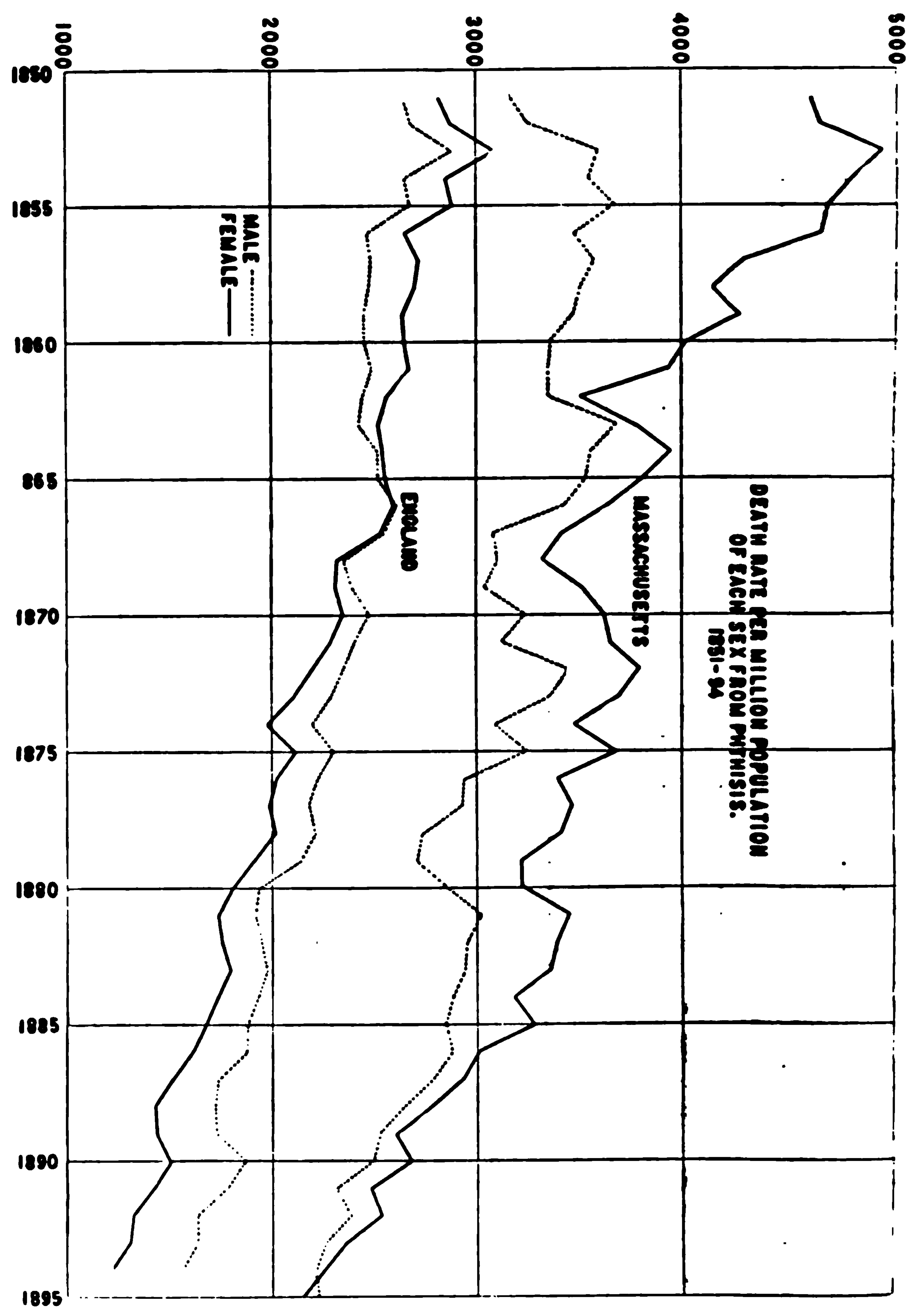
The death-rate of males was 33.4 per 10,000 living in the first period and 26.4 in the second, while that of females was 37.8 in the first and 29.1 in the second, thus showing a greater improvement among females than among males.

In the table on page 787 are given the death-rates per million living of each sex by single years for a still longer period (1851–95), and also a comparison of the male and female rates, the former being taken as 1,000, by which it appears that for the ten-year period 1851 to 1860 the mean death-rate of females from consumption to that of males was as 1,296 to 1,000, in the next decade (1861 to 1870) as 1,095 to 1,000, in the third as 1,154 to 1,000, in the fourth as 1,094 to 1,000, and for the single years 1891, 1892, 1893, 1894 and 1895, as 1,074, 1,067, 1,043, 1,020 and 974 females, respectively, to 1,000 males, the female death-rate from this cause being less than that of males for the first time in 1895.

TABLE 57.—*Phthisis. Annual Death-rates among Persons, Males and Females, in Each Million Living, Massachusetts, 1851–95.*

YEAR.	Persons.	Male.	Female.	Female Rate to Male Rate taken as 1,000.
1851, ...	3,901	3,166	4,600	
1852, ...	3,967	3,246	4,645	
1853, ...	4,272	3,592	4,917	
1854, ...	4,179	3,543	4,781	
1855, ...	4,195	3,680	4,669	1,296
1856, ...	4,083	3,475	4,649	
1857, ...	3,950	3,572	4,303	
1858, ...	3,842	3,506	4,157	
1859, ...	3,886	3,473	4,270	
1860, ...	3,702	3,357	4,025	
1861, ...	3,653	3,349	3,934	
1862, ...	3,428	3,343	3,504	
1863, ...	3,726	3,677	3,768	
1864, ...	3,757	3,554	3,941	
1865, ...	3,678	3,532	3,809	1,095
1866, ...	3,531	3,420	3,631	
1867, ...	3,255	3,080	3,416	
1868, ...	3,220	3,105	3,326	
1869, ...	3,288	3,038	3,517	
1870, ...	3,433	3,235	3,617	
1871, ...	3,393	3,125	3,643	
1872, ...	3,626	3,444	3,796	
1873, ...	3,536	3,360	3,698	
1874, ...	3,280	3,076	3,469	
1875, ...	3,474	3,244	3,685	1,154
1876, ...	3,176	2,936	3,398	
1877, ...	3,204	2,926	3,461	
1878, ...	3,085	2,734	3,408	
1879, ...	2,975	2,706	3,223	
1880, ...	3,081	2,861	3,285	
1881, ...	3,245	3,025	3,450	
1882, ...	3,179	2,953	3,388	
1883, ...	3,160	2,941	3,363	
1884, ...	3,037	2,877	3,184	
1885, ...	3,066	2,846	3,270	1,094
1886, ...	2,951	2,875	3,022	
1887, ...	2,856	2,781	2,925	
1888, ...	2,708	2,637	2,774	
1889, ...	2,565	2,527	2,600	
1890, ...	2,587	2,498	2,671	
1891, ...	2,396	2,309	2,479	1,074
1892, ...	2,453	2,371	2,530	1,067
1893, ...	2,310	2,260	2,358	1,043
1894, ...	2,234	2,211	2,255	1,020
1895, ...	2,194	2,224	2,166	974

In the diagram on this page the same figures are illustrated and show the wide divergence in the death-rate of the sexes in the early



years of the half-century, and their rapid approach up to 1863, from which date the death-rates continue nearly parallel until 1891, when

they again approach rapidly and the male death-rate becomes the greater in 1895.

The diagram also illustrates the figures for England* in similar manner, and shows, first, that in every year the consumption death-rate of England was less than that of Massachusetts, and secondly, that the death-rate of females was at first greater than that of males, but became less in 1866, a much earlier date than that of Massachusetts for the same occurrence.

Seasons of the Year. — In tables 48–51 it appears that consumption has proved fatal in Massachusetts with considerable uniformity throughout the year, the greatest and least mortality from this cause (upon a daily standard of 100) being in March (106.4) and in June (92.2) in the first period, and in April (110.4) and July (93.7) in the second period. The uniformity of its seasonal mortality is therefore greater than that of any of the other diseases enumerated.

Ages. — The highest death-rate from consumption in the first period was at the age period 70 to 80, when it was 87.6 per 10,000 living; that of the age period 20 to 30 was 51.7, and consequently the disease at this age proved fatal to much larger numbers, since the persons living were much greater in number at that age. The lowest death-rate was at ages 5 to 10 and 10 to 15 (page 769).

In the second period (1876–95) the highest death-rate was at ages 20 to 30, and the lowest at ages 5 to 10 and 10 to 15 (page 771).

The greatest improvement, comparing the two twenty-year periods, was at ages 60 and over, the death-rate at these ages in the second period being less than half that of the first period at the same ages. (More definite details relating to the mortality from consumption by sexes and ages will be given in the section entitled "Consumption in its Relation to the Wage-earning Period of Life.")

* From Registrar-General's last decennial report.

TABLE 58. — *Deaths from All Tubercular Causes and from Consumption only at Certain Ages compared with the Total Mortality at the Same Ages for the Two Years 1856 and 1857, and the Two Years 1894 and 1895.*

Deaths at Stated Periods of Life, 1856–57.

	Years.	All under 15 Years.			15–60.			All over 60.		
		Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Total.
All tubercular causes,	1856 and 1857	1,171	1,131	2,302	2,879	4,078	6,957	664	762	1,426
Pulmonary phthisis only,	1856 and 1857	486	552	1,038	2,833	4,010	6,843	637	745	1,382
All causes,	1856 and 1857	10,262	8,907	19,169	6,923	7,896	14,819	3,657	4,044	7,701

Deaths from Consumption and Other Tubercular Causes in Each 1,000 Deaths from All Causes at Same Periods of Life.

	Years.	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Total.
All tubercular causes,	1856 and 1857	114.1	126.9	120.1	415.8	516.3	469.3	181.6	188.4	185.2
Pulmonary phthisis only,	1856 and 1857	47.4	61.9	54.1	409.1	508.6	462.3	174.2	184.2	179.5

Deaths at Stated Periods of Life, 1894–95.

	Years.	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Total.
All tubercular causes,	1894 and 1895	2,000	1,850	3,850	4,627	4,985	9,612	564	572	1,136

TABLE 59.—*Deaths from Consumption at the Wage-earning Period of Life at Separate Ages.*

1856-57.

	15-20.			20-30.			30-40.			40-50.			50-60.		
	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Total.
Phthisis,	263	518	781	913	1,505	2,418	720	970	1,690	521	601	1,122	415	422	837
All causes,	674	915	1,589	1,896	2,599	4,495	1,608	1,925	3,533	1,438	1,344	2,782	1,307	1,113	2,420
Per 1,000 deaths,	390.2	566.1	491.6	481.6	578.8	537.9	447.2	503.9	478.4	362.3	447.2	403.3	317.5	379.1	345.9

1894-95.

	15-20.			20-30.			30-40.			40-50.			50-60.		
	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Total.
Phthisis,	425	626	1,051	1,575	1,854	3,429	1,254	1,268	2,522	720	667	1,387	518	368	886
All causes,	1,199	1,369	2,568	3,956	4,121	8,077	3,898	3,805	7,703	3,551	3,482	7,033	4,100	3,893	7,993
Per 1,000 deaths,	354.5	457.3	400.6	398.1	450.0	424.4	321.7	333.3	327.5	202.7	191.5	197.2	126.3	94.5	110.8

TABLE 60. — *Deaths from Consumption and Other Tu Children under Fifteen Years of Age, with Ratio to Ages.*

1856-57.

	0-5 Years. Males.	Females.	
All tubercular causes,	[illegible]	899	1
Pulmonary phthisis only,	396	364	
All causes,	8,881	7,545	16

In Each 1,000 Deaths from All Causes at

From all tubercular causes,	115.3	119.2	1
From pulmonary phthisis only,	44.6	48.3	

1894-95.

	0-1 Years. Males.	Females.	
All tubercular causes,	1,351	1,167	2
Pulmonary phthisis only,	129	109	
All causes,	11,918	9,545	21,

In Each 1,000 Deaths from All Causes at

All tubercular causes,	113.3	122.3	11
Pulmonary phthisis only,	10.8	11.4	1

1894-95.

In Each 1,000 Deaths from All Causes at Ages

	0-5 Years.		
All tubercular causes,	110.1	113.8	11
Pulmonary phthisis only,	15.1	16.2	1

Table 60. — ***Deaths and Death-rates from Consumption and Other Tubercular Diseases at Certain Ages of Life.***

1856–57.

	All under 15.			15–60.			All over 60.		
	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Total.
All tubercular diseases, ...	1,171	1,131	2,302	2,879	4,076	6,957	664	762	1,426
Pulmonary phthisis only, ...	486	569	1,055	2,832	4,016	6,848	637	745	1,382

Deaths to Each 10,000 Living at Same Ages.

All tubercular diseases, ...	[illegible]	30.6	31.2	41.3	54.6	48.5	102.7	[illegible]	100.6
Pulmonary phthisis only, ...	13.1	15.0	14.1	41.1	53.8	47.7	98.4	96.7	97.5

1894–95.

All tubercular diseases, ...	2,000	1,859	3,859	4,627	4,985	9,612	564	572	1,136
Pulmonary phthisis only, ...	339	408	747	4,492	4,783	9,275	494	426	920

Deaths to Each 10,000 Living at Same Ages.

All tubercular diseases, ...	30.4	28.5	29.4	29.7	29.9	29.8	30.3	25.2	27.5
Pulmonary phthisis only, ...	5.2	6.2	5.7	28.8	[illegible]	28.8	26.7	18.6	22.8

TABLE 61. — *Mortality from Tuberculosis in General and from Pulmonary Tuberculosis, at Different Ages.*

Country or State.	Disease.	Year.	Deaths from Consumption, etc., out of each 1,000 Deaths from All Causes at the same Ages.				During the Period 15-60 Years there died out of each 1,000 Deaths from All Causes at the following Ages:—				
			0-1 Year.	1-15 Years.	15-60 Years.	60 Years and Over.	15-20.	[illegible]30.	30-40.	40-50.	50-60.
Germany,	Tuberculosis,	1892-93	10.7	65.6	321.7	61.7	-	-	-	-	-
Germany,[1]	Pulmonary tuberculosis,	1892-93	7.1	46.0	289.3	56.5	-	-	-	-	-
Berlin,	Tuberculosis,	1892-96	14.7	75.4	338.0	58.6	-	-	-	-	-
Bavaria,	Tuberculosis,	1892-96	12.6	113.7	309.3	54.5	-	-	-	-	-
England,	Phthisis, tubercular meningitis (acute hydrocephalus), other forms of tuberculosis and scrofula,	1886-90	33.1	101.9	228.4[2]	12.4[3]	-	-	-	-	-
England,	Phthisis only,	1886-92	5.1	35.1	213.1[2]	11.7[3]	-	-	-	-	-
France,[4]	Pulmonary phthisis, tubercular meningitis and other tubercular diseases,	1892-94	22.1	193.2[5]	316.8[6]	21.9	-	-	-	-	-
France,	Pulmonary phthisis only,	1892-94	6.3	111.7[5]	279.3[6]	25.7	-	-	-	-	-
Paris,	Pulmonary phthisis, tubercular meningitis and other tubercular diseases,	1892-94	31.8	231.0	400.7	46.9	-	-	-	-	-
Paris,	Pulmonary phthisis only,	1892-94	9.1	126.6	369.9	43.3	-	-	-	-	-
Vienna,	Tubercular diseases, including pulmonary tuberculosis,	1891-92	46.5	290.0	459.0	93.5[7]	624.6	643.0	540.9	386.2	238.2
Vienna,	Pulmonary tuberculosis only,	1891-92	40.1	171.5	427.4	88.2	574.9	597.6	505.3	361.6	217.1
Belgium,	Tuberculosis of the lungs, the joints, the meninges and the brain,	1885-94	48.3	196.5	371.2	28.0	466.9	529.0	491.3	334.0	169.2
Belgium,	Pulmonary phthisis only,	1885-94	6.0	51.5	364.7	27.4	442.7	520.9	484.7	327.8	167.7
Denmark,[8]	Tuberculosis in general,	1885-89	16.0	114.9	296.6[2]	60.1	-	-	-	-	-
Denmark,	Pulmonary phthisis,	1885-89	5.9	72.4	276.7[2]	47.7	-	-	-	-	-
Massachusetts,	Tuberculosis in general (including tabes mesenterica),	1894-96	117.3	96.5	288.0	44.2	424.1	456.9	335.7	206.9	190.6
Massachusetts,	Pulmonary phthisis,	1894-96	11.1	37.5	277.9	36.8	409.6	424.4	337.5	197.2	110.8

[1] Except Bavaria. [2] 15 to 65 years. [3] 65 and over. [4] Cities having over 30,000 inhabitants in each.
[5] 1 to 20 years. [6] 20 to 60 years. [7] Deaths of persons of unknown ages are included in this group.
[8] The figures for Denmark are from "Denmark, its Medical Organization, Hygiene and Demography." Copenhagen, 1891.

The greater part of the figures in this table (Table 61) are from a circular of the Imperial Board of Health of Germany, upon the establishment of hospitals for consumptives, published at Berlin, 1896.

This high death-rate of infants under one year in Massachusetts (see column for infants under one year, in foregoing table) is the result of including all deaths certified as deaths from tabes mesenterica, which constitutes over 70 per cent. of the deaths embraced in this group. The rejection of these reduces this ratio (117.3) to 33.6, and makes it comparable with others in the same column, and especially with those of England.

The figures for older ages are affected but little by including tabes mesenterica, since most of the certified deaths from this cause occur in the first year of life.

Consumption in its Relation to the Wage-earning Period of Life.

The question of the prevention of tuberculosis has assumed so much importance in recent years as to make it necessary to present the vital statistics of this cause of death in such form as will be useful for consultation in the most practical manner possible. The disease, unfortunately, affects a very large proportion of the population. It seriously impairs their usefulness, and this, too, at a period of life when the capacity to earn a living is at its maximum.

The highest death-rate from consumption at any age of life is that which prevails at the age period twenty to thirty, although in the earlier years of the last half-century the death-rate from this disease was slightly greater at the age period seventy to eighty. For the twenty-five years 1863–87 the death-rate from this cause at the age period twenty to thirty was 49.4 per 10,000 of the living at that age, and 62.1 of the living at ages seventy to eighty. (See forty-sixth registration report, 1887, page 361.) This excess at advanced ages has disappeared in recent years.

For the purpose of ascertaining the changes which have taken place during the forty-year period 1856–95 we have here presented the deaths from consumption during the first two and the last two years of the period at certain specified ages, and also the deaths from all tubercular diseases, in separate lines. (See tables 57–60.) The diseases embraced in this enumeration are phthisis, or pulmonary tuberculosis, hydrocephalus, tabes mesenterica and scrofula. To these are added the few deaths certified as due to lumbar abscess, cellulitis and goitre, in all amounting to a fraction only of 1 per cent. of the total of tubercular deaths.

The periods of life selected for comparison are three in number, namely, all under fifteen years, fifteen to sixty, and all over sixty years, and in each case the deaths of each sex are also given separately.

For the two years 1894–95 the age period, all under fifteen, is also divided into two periods, all under one year and those from one to fifteen years of age. This was not possible for the years 1856–57, without an undue amount of laborious research, since the deaths under one from different causes were not separately published until 1887, when they were introduced into the registration reports by request of the State Board of Health. Hence an additional short table has been added at the bottom (1894–95, 0–5, 5–15 years) in order to make the figures of the latter period comparable with those of the former.

The principal value of these tables consists in the presentation which they set forth of the relation of consumption to the productive or wage-earning period of life. It is at this time of life that consumption proves by far the most destructive, and that, too, in the earlier part of the period, when the wage-earning capacity is at its maximum.

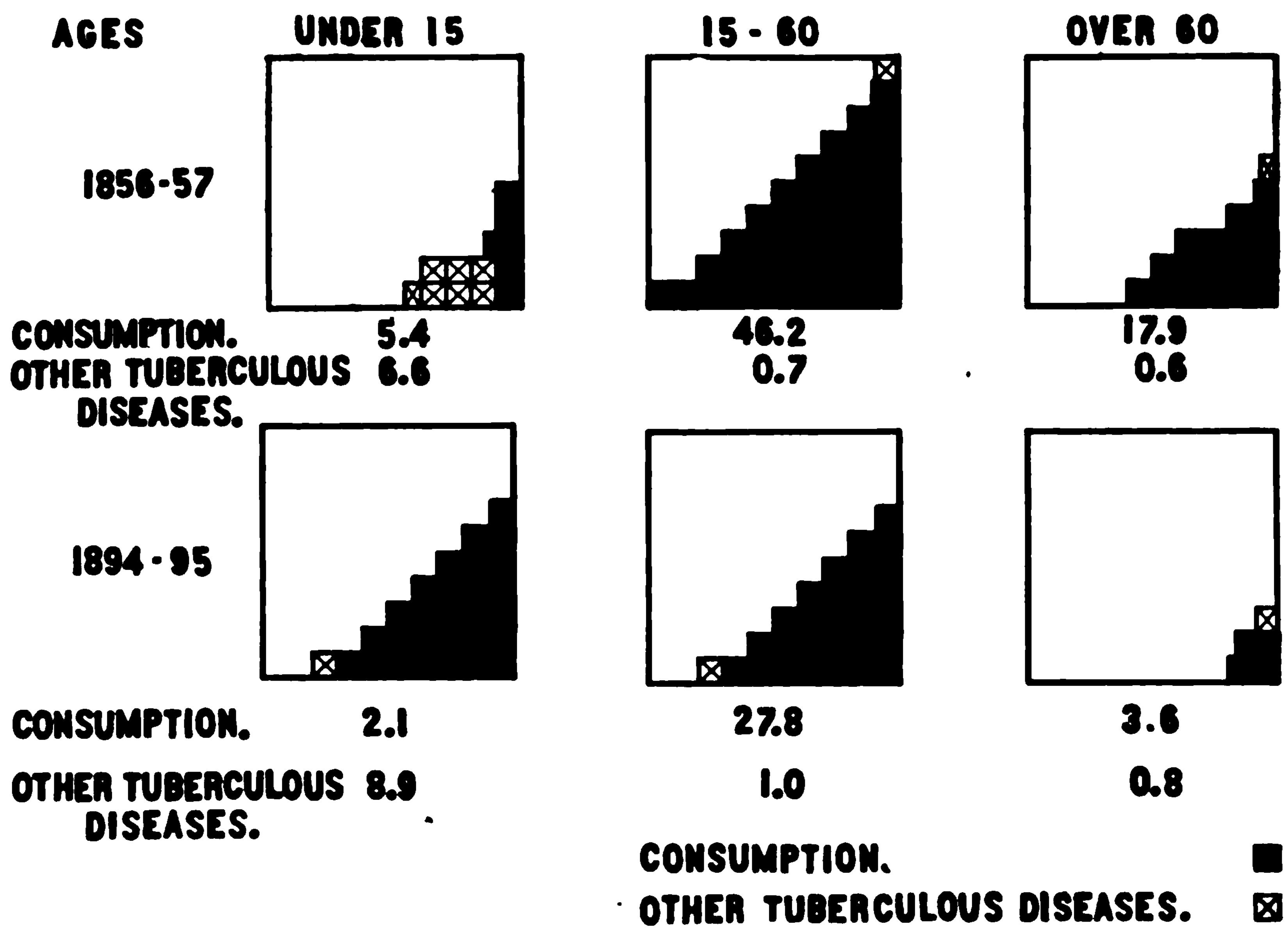
The method of presentation, the comparison of the number of deaths from this cause with the total number of deaths from all causes, is, we are aware, faulty and open to certain objections, hence we have also presented the same deaths in comparison with the living population at the same ages of life. (See Table 60, page 793.)

The former method was selected in this case and given greater prominence in order to bring out, in the most striking manner, the excessive destructiveness of this disease upon persons of certain ages at the time when their usefulness as wage-earners is at its maximum, and secondly, in order to be enabled to compare the statistics of this character with those of other countries recently published. These figures are presented by the Imperial Board of Health of Germany in a recent circular upon the "Advantages of Institutions for the Treatment of Lung Diseases."*

PERCENTAGE OF DEATHS FROM TUBERCULOSIS (IN GENERAL) TO DEATHS FROM ALL CAUSES IN DIFFERENT POPULATIONS AT THE WAGE-EARNING PERIOD OF LIFE (15-60 YEARS).

* Ein Beitrag zur Beurtheilung des Nutzens von Heilstätten für Lungen Kranke. Berlin, 1896.

By these tables (page 790) it appears that in every 1,000 deaths from all causes among persons from fifteen to sixty years of age, in the two years 1856 and 1857, 469 were from tuberculosis in general; those of males were 416 and those of females were 516, — in the latter case constituting more than half the deaths from all causes at that period of life. In 1894 and 1895 these figures were reduced to 288 for both sexes, or to 277 in males and 299 in females. In the accompanying diagram for different populations the open squares represent the deaths from all causes and the shaded portions the percentage of deaths from tuberculosis in general.



PERCENTAGES OF DEATHS FROM CONSUMPTION AND OTHER TUBERCULAR DISEASES TO TOTAL DEATHS AT EACH OF THREE PERIODS OF LIFE (UNDER 15, 15-60 AND OVER 60), IN 1856-57 AND 1894-95, MASSACHUSETTS.

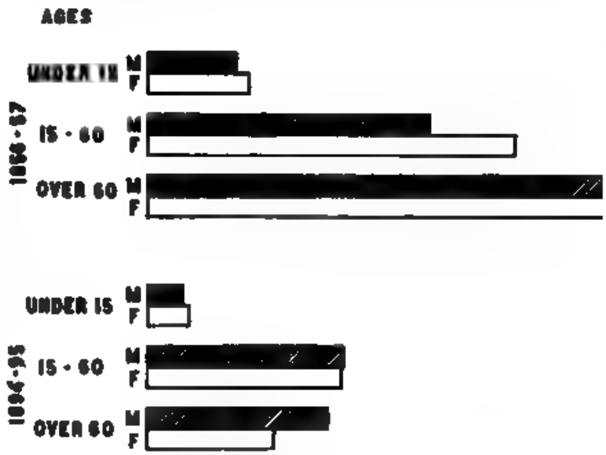
It also appears that in every 1,000 deaths from all causes among persons from fifteen to sixty years of age in the two years 1856 and 1857, *462* were from phthisis or consumption of the lungs. Those of males were *409* and those of females *509*, in the latter case being more than half the deaths from all causes. In the two years 1894 and 1895 these figures were reduced to *269* for males and *287* for females. (See Table 57, page 790.)

In the age period of life twenty to thirty the mortality was still greater, being, in the two years 1856 and 1857, *482* for males and

579, out of each 1,000 deaths of females. The f
period had also fallen to *398* and *450*, respec
years 1894 and 1895. (See Table 58, page 791.

These tables also show that the excess of fen
consumption among persons over sixty years
years 1856 and 1857, had disappeared in the t
1895, and given place to an excess of such mort
They also show the rate of mortality from other t
(not pulmonary phthisis) among children under f

In Table 60 the deaths and death-rates from co
all tubercular diseases at each of the three period
fifteen, fifteen to sixty and all over sixty, are pr
periods 1856–57 and 1894–95, and show a mark
the death-rate from pulmonary phthisis at each of
especially in childhood and old age. The same fi
for phthisis in the accompanying diagram.



COMPARATIVE MORTALITY OF MALES AND FEMALES FROM CONSUMPTI
LIFE (UNDER 15, 15–60 AND OVER 60) IN 1856-57 AND 1894-95,

Pneumonia.

Total deaths, 1856–95, 101,226.

The deaths registered from pneumonia in 189
the death-rate 18.6. This was higher than that
siderably less than those of 1892 and 1893.
these three years, 1892, 1893 and 1894, were,
23.0 and 16.8.

The course of pneumonia shows a marked cont

majority of infectious diseases, in that it has risen from a death-rate of 8.5 in 1856 to one of 23.0 in 1893. The increase of pneumonia, however, has been marked by greater irregularities than are presented by the decline of consumption.

The total deaths from this cause in the first period were 32,868, and those of the last period were 68,358, making an aggregate of 101,226 in the forty years ending with 1895. The death-rate of the first period was 12.2 per 10,000 and that of the latter was 16.8. The death-rates of the five-year periods were respectively as follows, from 1856 to 1895: 9.6, 11.9, 11.8, 14.7, 14.2, 16.0, 16.4, 19.7.

In a paper read by Dr. C. F. Folsom at the meeting of the American Association of Physicians in Washington, May 1, 1896, the author presents a diagram showing the death-rate from pneumonia in England and in Glasgow from 1852 to 1894. It is therein shown that pneumonia in Glasgow has followed a course in its death-rate very similar to that of Massachusetts, especially since 1858, while in England the death-rate from this cause has diminished down to 1890, when it again increased.

Seasonal Prevalence. — The seasonal mortality of pneumonia indicates a comparatively uniform course throughout the forty years and for the eleven months from February to December inclusive; but the relative death-rate of January appears to be considerably greater in the second period than in the first, probably in consequence of the unusual prevalence of epidemic influenza in the winter of 1889–90 and the three following years. (See forty-ninth registration report, 1890, page 347, and twenty-first annual report of State Board of Health, page 307.)

The greatest maximum departure from the mean annual death-rate from this cause was in March in the first period and in January in the second, and the greatest minimum departure was in August in each period.

Sex. — There was in each period a greater death-rate of males than of females, but the difference was greater in the first period than in the second, the ratio being as 117 males to each 100 females in equal numbers living in the first period, and as 110 males to each 100 females in the second.

Age. — The death-rate appears to have increased at each age of life, but the greatest relative increase occurred at all ages above twenty years. The death-rates at different ages bore nearly the same relative proportion to each other in each period. For example,

the death-rate of age 5 to 10 and age 10 to 15 in the first period were respectively 8.6 and 3.7 per cent. of the death-rate at age 0 to 5, while in the second period they were 9.1 and 3.8 per cent. of the death-rate at that age. At older ages the differences were greater.

Kidney Diseases.

Total deaths, 1856–95, 26,219.

The whole number of deaths ascribed to this cause in 1895 was 1,860, and the death-rate 7.4 per 10,000 of the population. Under this head are embraced all deaths included in the registration reports under the titles "diseases of the kidneys," "nephritis," "nephria" and "Bright's disease." At the suggestion of the State Board of Health the obsolete term "nephria" was stricken from the list after 1887.

The total deaths from this group of causes registered during the forty years were 26,219, of which 4,062 occurred in the first twenty years and 22,157 in the last twenty years. The death-rate of the first period was 1.5 per 10,000 and that of the second was 5.5. The rapid and comparatively uniform increase in the death-rate is remarkable, the minimum death-rate being that of the first three years (1856–58), or .4, and the maximum, 7.4, was that of 1895, the last year of the period.

Sex. — Reference to Table 123 of the forty-sixth registration report (1887) shows that the death-rate of males was generally greater than that of females. In a ten-year period (1878–87) there were 5,291 deaths of males and 3,720 of females from kidney diseases.

Since the diagnosis of diseases of the kidneys has progressed rapidly during the forty years embraced in this period, it is fair to infer that a considerable part of the increase may be due to the transfer to this title of cases which would in earlier times have been referred either to the title of "dropsy," or to that of unknown causes. (See table on page 356 of registration report of 1890, in which it appears that deaths certified as due to kidney diseases had increased more than twentyfold in the forty years 1851–90, while the death-rate ascribed to dropsy in the last years of the period had fallen to less than one-fifth of that which is shown in the first ten years of the period. The result of these changes is shown in the sum of the deaths ascribed to kidney diseases and dropsy, wherein the actual increase in the death-rate from these combined causes is only 50 per cent. for the whole period.)

Heart Diseases.

Total deaths, 1856-95, 67,989.

The whole number of deaths registered as due to heart diseases in 1895 was 3,566, and the death-rate was 14.3 per 10,000. This death-rate was slightly higher than that of 1894 from the same cause, but was less than that of any previous year since 1887.

The total mortality from heart diseases in the forty-year period was 67,989, of which 17,550 occurred in the first half and 50,439 in the last half, the death-rates being respectively 6.5 and 12.4. The minimum death-rate from this cause was 4.9, which occurred in each of the years 1858 and 1859, and the maximum was 16.0, in 1892.

Sex. — Reference to Table 125, registration report of 1890, shows that the death-rate of males from heart disease was slightly greater in number than that of females.

Ages. — In Table 126 of the same report are presented the death-rates from heart disease by ages. From these we have selected the column for 1855, and have added the figures for 1895, these being very nearly the extreme years of the forty-year period under consideration.

By this table it appears that the death-rate has increased at each age period, but the increase has been much the greatest at advanced ages. A comparison of the table referred to with the following table shows that the death-rate at each age in 1890 was greater than that of 1895 at corresponding ages.

The increasing use of the indefinite term "heart failure," as affecting the statistics of this group of causes, has received sufficient comment in the forty-ninth registration report, Massachusetts, 1890 (page 363).

TABLE 62. — *Death-rates by Ages, 1855 and 1895, per 10,000 Living at Each Age.*

Ages.	1855.	1895.	Ages.	1855.	1895.
0,	5.9	7.2	40,	5.5	11.9
5,	1.4	1.6	50,	8.6	28.3
10,	1.3	1.9	60,	20.9	61.5
15,	1.8	2.6	70,	27.1	136.1
20,	2.0	3.2	80,	36.8	186.4
30,	2.8	6.0			

Brain Diseases.

Total deaths, 1856–95, 114,036.

The diseases embraced under this group are those which are included in the registration reports under the titles "apoplexy," "paralysis," "insanity," "softening of the brain," and the general terms "cephalitis" and "unspecified diseases of the brain." The unsatisfactory term "cephalitis" has been employed for many years in the registration reports as a makeshift, to include all inflammatory and other diseases of the brain which it was found difficult to place under other titles.

The number of deaths from this group of causes in 1895 was 5,062 and the death-rate 20.2, which was less than that of any year since 1890.

The whole number of deaths in the forty years from brain diseases was 114,036, of which 36,054 occurred in the first half and 77,982 in the last half of the period. The death-rate of the first half was 13.4 and that of the last half 19.2, or not quite 50 per cent. greater. That of the minimum year (1856) was 9.4, and that of the maximum years (1892 and 1893) was 21.5 per 10,000.

Cancer.

Total deaths, 1856–95, 31,140.

The deaths registered as from cancer in 1895 were 1,749. This was a much larger number than that of any previous year. The death-rate was 7.0 per 10,000, as compared with 6.4 in 1894. There has been a very steady and comparatively uniform increase in the death-rate from this cause from a minimum of 1.9 in 1856, the first year of the period, to 7.0 in 1895, the last year.

The total number of deaths from cancer in the whole period of forty years was 31,140, of which 8,219 occurred in the first twenty years and 22,921 in the last twenty years. The death-rates of the two periods were respectively 3.0 and 5.6. Those of the five-year periods were as follows: 2.3, 2.7, 3.3, 3.7, 4.5, 5.4, 5.9, 6.4.

In the early registration reports the term "cancer" appears alone, without specification as to its seat or location; the term "cancer of the stomach" first appears in the report of 1867, "epithelioma" in 1876, "cancer of the liver and uterus" in 1878, "of the bowels" in 1881, and of the "breast," "spleen," "kidneys" and "pancreas" in 1887.

The following figures show a similar steady increase in the death-rate from cancer in England and Wales: —

*Deaths from Cancer per 10,000 of the Population in England and Wales.**

1861-70,	3.9
1871-80,	4.7
1881-90,	5.9

Child-birth.

Total deaths, 1856-95, 12,075.

But little account has been taken in the registration reports of the changes which have occurred in the mortality from the diseases and incidents of child-birth. Hence a column has been introduced in Table 46 in which these data are presented.

It is desirable to state clearly at the outset what deaths should be included under this title, since several terms are employed, and also what shall be the standard of comparison in stating a death-rate. It was therefore decided to include all deaths classed as from child-birth (under this term are embraced all deaths specified as from abortion, child-birth, miscarriage and puerperal convulsions), puerperal fever, metritis, metria,† puerperal septicæmia, and the excess of female deaths from septicæmia over those of males.

With reference to the standard of comparison these deaths are those of one sex only, and mostly at ages from fifteen to forty-five, hence it seemed best not to employ the living population as a standard, as is done in the other columns of the table, nor should the living births be used as a standard, since still-births subject the mothers to the same puerperal dangers as living births. The standard employed is, therefore, the number of cases of births occurring in each year, obtained by taking the sum of cases of living and of still births.‡ Each case of plural birth is also reckoned as a single case. The relative figures represent deaths per 10,000 cases of birth, and show a considerable decrease comparing the two periods. The whole number of cases of birth in the forty years was 1,820,756, and the deaths by child-birth, etc., 12,075, or 66.3 per 10,000. In the first period (1856-75), with 745,461 cases of birth, there were 5,584 deaths in

* Registrar-General's Decennial Supplement, vol. 1, London, 1895, page 54.

† An obsolete term adopted by Dr. Farr.

‡ This method was adopted in order to make the figures comparable with those of other countries.

child-birth, or 74.9 per 10,000, and in the second period (1876–95) 1,075,295 cases of birth produced 6,491 deaths, or 60.4 per 10,000.

The death-rates by five-year periods were as follows: 68.6, 68.1, 76.2, 83.8, 73.3, 72.9, 54.4, 48.2.

There appears to have been an increase up to the fourth period, and then a greater decrease to the close.

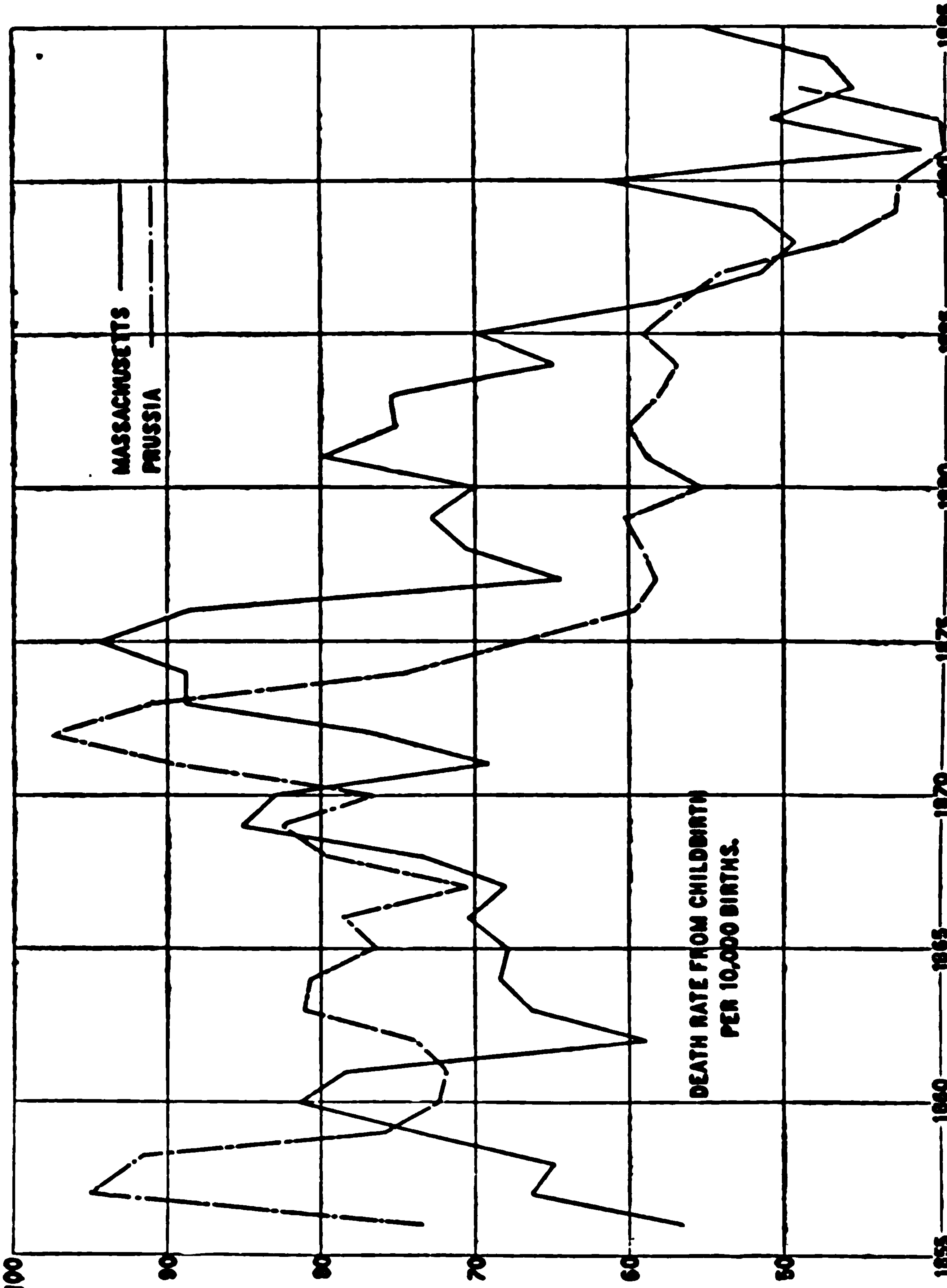
In the following table and diagram are presented the figures for Massachusetts and those of a similar table published by Brennecke for Prussia, in each of which a rise appears during the first half of the period and then a greater fall to the close of the table: —

TABLE 64.

Year.	Massachusetts.		Death-rate per 10,000.		Prussia (Death-rate per 10,000).	
	Births.	Deaths in Child-birth.	Annual.	Five-year Periods.	Annual.	Five-year Periods.
1856,	34,858	197	56.5		78.4	
1857,	35,688	237	66.4		95.0	
1858,	34,895	226	64.8	68.6	91.6	81.8
1859,	35,805	263	73.5		75.9	
1860,	36,769	299	81.3		72.3	
1861,	36,090	283	78.4		71.8	
1862,	33,514	197	58.8		73.8	
1863,	30,904	205	66.3	68.1	81.0	78.0
1864,	31,005	212	68.4		80.6	
1865,	30,810	209	67.8		76.5	
1866,	34,776	245	70.4		78.5	
1867,	35,726	243	68.0		70.5	
1868,	36,879	271	73.5	76.2	79.7	77.7
1869,	36,884	314	85.1		82.5	
1870,	38,928	323	83.0		76.7	
1871,	40,809	282	69.1		89.5	
1872,	44,137	338	76.6		97.6	
1873,	45,308	402	88.7	83.8	91.0	84.8
1874,	46,692	414	88.7		74.4	
1875,	44,984	424	94.3		67.4	
1876,	43,070	381	88.5		59.6	
1877,	42,693	275	64.4		58.2	
1878,	42,088	297	70.6	73.3	59.1	58.6
1879,	41,201	300	72.8		60.2	
1880,	45,127	316	70.0		55.3	
1881,	46,279	370	79.9		58.8	
1882,	46,728	351	75.1		60.0	
1883,	48,469	366	75.5	72.9	58.0	58.5
1884,	49,801	323	64.9		56.8	
1885,	49,994	350	70.0		59.0	
1886,	52,121	303	58.1		56.6	
1887,	54,505	280	51.4		53.8	
1888,	56,395	277	49.1	54.4	46.6	48.6
1889,	58,543	303	51.7		43.1	
1890,	59,366	365	61.5		42.8	
1891,	64,593	269	41.6		40.0	
1892,	67,529	343	50.8		40.4	
1893,	69,006	317	45.9	48.2	49.0	43.8
1894,	68,627	325	47.4		-	
1895,	69,158	380	54.9		-	
1856–95,	1,820,756	12,075	66.3	-	-	-

The column of figures for Prussia in this table is taken from a paper by Dr. H. B. Brennecke of Magdeburg, entitled "Errichtung von Heimstätten für Wochnerinnen,"* and extends over a period of fifty years (1844–93). It contains the statistics of 296,867 deaths from child-birth and its incidents out of 44,095,659 cases of labor.

Death-rates from Child-birth, Massachusetts and Prussia, 1856–95.



In commenting upon that portion of the foregoing table which relates to the mortality of child-bearing women in Prussia, Brennecke

* Vierteljahrsschrift für öff. Gesundheitspflege, 1897, page 81, vol. 29.

says: "Hegar in 1892, at the gynæcological congress in Bonn, properly called attention to the fact that the sudden and surprising fall of the puerperal mortality curve in 1874 was not due to the influence of antiseptics (which were not employed at that time in the country districts), but may be attributed solely to the fact that in 1874 the administration of the official registration passed out of the hands of the clergy into those of the civil authorities. I have no doubt," says Hegar, "that the collection of the statistics was conducted more accurately by the clergy than by the civil authorities, since in the country districts the clergy are especially well informed as to the condition of the families under their care. They are summoned in cases of child-birth, and know when death in childbed occurs. The civil authorities are not so well informed."

Whether the foregoing comments in regard to the cause of the changes in the death-rate from the incidents of child-birth in Germany are correct is a question. They certainly do not apply to the similar column of statistics for Massachusetts, since while the Massachusetts column shows precisely the same sudden fall three years later, it is not true that any change in the methods or the authorities collecting the statistics have here taken place, since they have from the very outset, in 1842, been collected by the city registrars and the town clerks throughout the State.

Certain Minor Causes of Death.

Cerebro-spinal Meningitis. — This term does not appear as a cause of disease in the published registration returns until 1873, in which year 747 deaths from this cause were registered, a number more than three times as great as that of any succeeding year from the same cause. During the few preceding years all deaths returned as from this cause were classed under the vague and indefinite term "cephalitis."

In the preceding year, 1872, Dr. Derby had called attention to the prevalence of cerebro-spinal meningitis, and had published a brief statement relative to the disease in the registration report of that year.

In the three years 1873, 1874 and 1875, the last years of the first twenty-year period under consideration, 1,159 deaths from this cause were registered, and when compared with the mean population of the three years the death-rate was 2.4 per 10,000 living.

In the second period the disease prevailed more or less in each year, the minimum mortality being 78 deaths in 1878 and the maximum, 171 in 1888, the total for the second period being 2,646, and the mean death-rate 0.65 per 10,000 for the whole period.

Erysipelas. — Total deaths, 1856–95, 7,688. The deaths from erysipelas in the first period were 3,565, and the mean annual death-rate 1.3. Those of the second period were 4,123, and the death-rate 1.0 per 10,000, thus showing a slight improvement, comparing the two periods. The maximum for the whole forty-year period was 262, in 1875, and the minimum 124, in 1862.

Influenza. — Total deaths, 1856–95, 4,315. The whole number of deaths registered as due to influenza in the first period was 943, and the mean annual death-rate per 10,000 from this cause was 0.35. In the second period the deaths were 3,372, and the mean annual death-rate 0.83 per 10,000.

In no year of the first period did the deaths attributed to this cause exceed 92 (1857), and in no year of the second period previous to 1890 did they exceed 48, but in 1890 they suddenly rose from 27 to 411, and in the six closing years of the period they were, respectively, 411, 546, 967, 296, 370 and 457, the deaths from this cause in these six years constituting more than 90 per cent. of all the recorded deaths from the same cause in the twenty-year period 1876–95. (For further information relative to the deaths from other diseases occurring coincident with the outbreaks of influenza, see forty-ninth registration report, 1890, pages 347–351, also a summary of the epidemic of 1889–90 in the twenty-first annual report of the State Board of Health, 1889.)

Malarial Fever. — Total deaths, 1856–95, 1,458. The deaths from malarial fever are those which are registered under the titles "ague" and "remittent fever." In the first period they were 465 in number and in the second 993, the mean annual death-rates being respectively 0.17 and 0.24 per 10,000 living. The highest number in any year was 86, in 1893, and the lowest 8, in 1859. During the years 1863–64 (the midst of the civil war) the numbers were nearly doubled, as compared with the mean annual number of that period.

Since the beginning of its recrudescence in Massachusetts in the second period the deaths from this cause have also notably increased, but, in consequence of its comparatively mild fatality, the death-rate from this cause has at no time been high. (For further information

relative to its prevalence, see reports of the Board for 1880, 1885 and 1889, also the second joint report of the State Board of Health and the Metropolitan Park Commission, 1895.)

Rheumatism. — Total deaths, 1856–95, 6,516. The deaths registered as from rheumatism in the first period were 2,329 and in the second 4,187, and the mean annual death-rates were respectively 0.86 and 1.03 per 10,000 living, thus showing a slight increase. The death-rate maintained a fairly uniform course, with a slight tendency to increase throughout the whole period.

Hydrophobia. — This disease appears occasionally as a spasmodic epidemic lasting for one or more years, but never proving very destructive to life. The following statistics are for the entire period of registration, ending with 1895.

There were no deaths registered from this cause in 1895 nor in 1894.

The number registered in the whole period of registration was 117. The number of deaths in each year was as follows: —

TABLE 65. — *Deaths from Hydrophobia, Massachusetts, 1842-95.*

1842-47,	0	1873,	0
1848,	1	1874,	0
1849,	3	1875,	0
1850,	1	1876,	4
1851,	1	1877,	14
1852,	0	1878,	15
1853,	2	1879,	5
1854,	6	1880,	3
1855,	1	1881,	3
1856,	0	1882,	0
1857,	1	1883,	0
1858,	2	1884,	0
1859,	3	1885,	0
1860,	2	1886,	0
1861,	0	1887,	0
1862,	0	1888,	2
1863,	1	1889,	14
1864,	1	1890,	17
1865,	0	1891,	9
1866,	0	1892,	1
1867,	1	1893,	2
1868,	0	1894,	0
1869,	0	1895,	0
1870,	2		
1871,	0	Total,	117
1872,	0		

The average number of deaths in each year from hydrophobia was but little more than 2, and in twenty-seven years, or just half the whole number of years (see foregoing table), there were no deaths from this cause. The two principal epidemics were those of 1876–81 and 1888–91.

Sex. — The deaths of males were 96, or 82 per cent., and the females were 21, or 18 per cent., of the whole number of deaths from this cause.

Ages. — The deaths by ages were as follows: —

0–5,	13	40–50,	9
5–10,	25	50–60,	10
10–15,	14	60–70,	6
15–20,	10	70–80,	2
20–30,	12	Over 80,	1
30–40,	14	Unknown,	1

By this table it appears that over 44 per cent. of the victims of this disease were children under fifteen years of age.*

Prevalence by Months. — The deaths by months were as follows: —

January,	8	July,	6
February,	9	August,	15
March,	10	September,	9
April,	10	October,	13
May,	10	November,	8
June,	10	December,	9

This table shows a fairly uniform distribution throughout the year, with the greatest number in August and the least in July.

Counties. — The distribution of the deaths by counties was as follows: —

Barnstable,	2	Middlesex,	27
Berkshire,	3	Nantucket,	0
Bristol,	14	Norfolk,	16
Dukes,	1	Plymouth,	3
Essex,	18	Suffolk,	14
Franklin,	3	Worcester,	7
Hampden,	7		
Hampshire,	2	Total,	117

In those communities where dogs are constantly muzzled, as in Berlin, hydrophobia has been practically "stamped out." (Further

* Out of 960 deaths from this cause in England from 1854 to 1888, 51 per cent. were among persons under twenty years of age.

information relative to this disease may be found in the twenty-second report of the Board, 1890, page xxvii.)

Comparing the two twenty-year periods 1856–75 and 1876–95 the deaths from hydrophobia in the former were 13 and in the latter 89, the death-rates being respectively 0.005 and 0.022 per 10,000 inhabitants, the death-rate having increased more than fourfold. These figures, however, are comparatively insignificant in consequence of their small number.

Glanders. — Total deaths, 1856–95, 23. No deaths were recorded from this cause until 1869, and there were only 9 in the first twenty-year period. In the second period the number of deaths from this cause was 14. It is worthy of note that 4 of these deaths, the greatest number in any one year, occurred in 1872, the chief epidemic year of the forty-year period.

Malignant Pustule. — Total deaths, 1856–95, 104. The whole number of deaths registered from this cause in the first period was 67, and those in the second period were 37, the mean annual death-rate having fallen from 0.025 to 0.009 per 10,000 living. Although the whole number of deaths is small, this decrease in the death-rate is notable. The deaths attributed to this cause occurred for the most part in a few small towns, in which the industries of tanning and of sorting horse-hair were conducted. During the first period attention was drawn to this form of disease and to the necessity of adopting measures for its prevention.

The greatest number of deaths in any one year (9) occurred in 1868 and in the first period, while the greatest number in any year of the second period was 5.

Alcoholism and Syphilis. — A certain number of deaths are certified every year as due to intemperance and syphilis. No summary of the statistics of these causes of death can have actual value as representing the prevalence of alcoholism and venereal diseases for the following reasons: —

Such returns cannot in any sense be regarded as an index of the prevalence of intemperance, since there can be no doubt that the desire to spare the feelings of surviving relatives limits the statement as to this cause of death to those cases where no disguise is possible.

The undue prominence of the cases reported in the more populous counties may be regarded as partly due to the public institutions existing in those counties. (From forty-ninth registration report, 1890, page 362.)

For a full digest of the deaths from violence reported by medical examiners as due directly or indirectly to intemperance in 1888, see forty-seventh registration report, Massachusetts, 1888, pages 399–405.

Fully two-thirds of the deaths credited to syphilis are those of infants under one year of age.

The Balance of Mortality.

The death-rate of Massachusetts has maintained a fairly uniform course throughout the forty years under consideration, comparing long periods of time with each other. That of the first twenty-year period was 19.49 and that of the second 19.51 per 1,000 of the living population. This uniformity was maintained notwithstanding the fact that one of the chief factors, the density of population, had more than doubled during the whole period of forty years. When single years are considered the variation from a mean of about 19.5 per 1,000 was quite apparent, the highest death-rates being 22.83 and 22.85 per 1,000 in 1864 and 1872, and the lowest 17 and 17.33 in 1867 and 1859, or 17.2 per cent. above and 12.8 per cent. below the mean for the two extremes.

The death-rate is composed of a variety of different factors; for example, the deaths of persons of different sexes and ages and persons dying from different causes. While the death-rate has remained nearly uniform, the factors which compose it have varied in a remarkable degree. Certain causes of death or general groups of causes have diminished notably in their incidence upon the population, while others have quite as notably increased. Infectious diseases generally, including consumption, have diminished, while most of the so-called local diseases (those of the nervous, respiratory, circulatory organs, etc.) have increased, and the result has been a balance or a maintenance of uniformity in the general death-rate.

The same facts have been observed in the vital statistics of other countries. (See the Registrar-General's decennial report, England, part 1, page xxiii, supplement to fifty-fifth report, also the paper of Dr. G. B. Longstaff, entitled "The Decline in the Death-rate.")

What the outcome of these changes may be in the future it is impossible to state. Should the marked decrease in the death-rates from consumption, typhoid fever, scarlet-fever and other infectious diseases continue for a series of years, it is plain that this decrease must be limited, since they can only fall to zero, while, on the other

hand, those causes of death which are increasing can continue to rise indefinitely. It is therefore desirable that greater attention should be paid in the future to those causes of death which cause the heaviest loss of life.

The changes here alluded to also affect the death-rates at different ages, since the diminishing causes of death (the infectious diseases) are mainly diseases of childhood and early life, while the increasing causes are chiefly those of advancing age, and the general effect would be the prolonging of the life of the population.

To quote again the words of Dr. Longstaff: "The gain under phthisis is more important than the loss under cancer, kidney diseases, etc., since the lives saved are more valuable than those which are lost."

The following table may be termed a balance-sheet of mortality. It presents the deaths for two successive ten-year periods, 1875–84 and 1885–94, and shows quite conclusively that while the difference in the death-rate of the two periods was comparatively slight, amounting to only 0.2 per 1,000 living, or 212 per million, the factors which contribute to the death-rate have undergone a material change.

Column 1 presents the names of certain diseases and groups of diseases or causes of death; columns 2 and 3 present the numbers of deaths from each cause or group of causes for each of two successive ten-year periods; columns 4 and 5 give the annual death-rate per million of the population from each cause; and columns 6 and 7 give the decrease and increase in the death-rate from each cause, comparing the two periods.

TABLE 66.—*Balance of Mortality (Massachusetts)*.*

Diseases and Groups of Diseases.	Deaths.		Annual Deaths per Million.		Annual Decrease.	Annual Increase.
	1875-84.	1885-94.	1875-84.	1885-94.		
1	2	3	4	5	6	7
Small-pox,	241	86	13	4	9	-
Measles,	1,669	2,100	94	95	-	1
Scarlet-fever,	7,118	4,771	401	217	184	-
Diphtheria and croup,	22,977	16,248	1,295	739	556	-
Whooping-cough,	2,764	2,781	156	126	30	-
Typhoid fever,	8,838	8,305	498	378	120	-
Cholera infantum,	19,702	23,805	1,110	1,082	28	-

* See note on page 814.

TABLE 66 — *Concluded.*

DISEASES AND GROUPS OF DISEASES.	DEATHS.		ANNUAL DEATHS PER MILLION.		Annual Decrease.	Annual Increase.
	1875-84.	1885-94.	1875-84.	1885-94.		
1	2	3	4	5	6	7
Dysentery, diarrhœa, cholera, enteritis, gastritis.	15,741	19,555	887	889	-	2
Rheumatism,	1,902	2,259	107	103	4	-
Dropsy,	3,487	1,795	196	82	114	-
Puerperal fever and child-birth,	3,137	2,584	177	117	60	-
Phthisis,	56,053	57,036	3,159	2,593	566	-
Scrofula, hydrocephalus and tabes mesenterica.	11,657	16,280	657	740	-	83
Cancer,	8,515	13,250	480	602	-	122
Brain diseases: cephalitis, apoplexy, paralysis, insanity, diseases of brain, etc.	30,677	45,896	1,729	2,087	-	358
Convulsions,	6,419	8,400	362	382	-	20
Heart diseases,	18,800	33,442	1,059	1,521	-	462
Diseases of lungs,	36,998	58,755	2,085	2,672	-	587
Kidney diseases,	7,410	13,890	418	632	-	214
Hepatitis, jaundice, ascites, disease of liver.	3,569	4,848	201	220	-	19
Developmental diseases,	34,304	42,152	1,933	1,917	16	-
Violence,	14,212	18,134	801	825	-	24
All specified diseases,	316,190	396,374	17,818	18,023	1,687	1,892
All others,	29,693	36,951	1,673	1,680	-	7
Total deaths from all causes, excluding still-births.	345,883	433,325	19,491	19,703	1,687	1,899
Balance of increase and decrease,	-	-	-	-	-	212

NOTE. — Allowance must be made for the effect of medical progress and more exact methods of diagnosis upon any series of figures covering a period of twenty years. The general effect is to change as well as improve existing systems of nomenclature and classification, and hence to disturb the significance of figures representing the causes of death during the period in question.

For example, the line entitled "dropsy" might be erased, and the deaths distributed in due proportions, chiefly under the titles "heart diseases," "kidney diseases" and "diseases of the liver," where they undoubtedly belong.

Part of the steady decrease in phthisis may possibly be due to a more accurate distribution of such deaths under pneumonia, developmental diseases, etc.

The general result, however, showing the decrease of infectious and the increase in local diseases, would not be very greatly affected by such distribution.

In the foregoing table the sum of the specific death-rates in columns 4 and 5 constitutes the mean annual death-rate per million from all causes for each ten-year period, namely, 19,491 and 19,703, or as usually read, 19.5 and 19.7 per 1,000 of the living population.

When reckoned in terms of the total mortality the result is the same. In the twenty years 1871–90 the following diseases, measles,

scarlet-fever, diphtheria and croup, typhoid fever and consumption, had diminished in their percentage of the total mortality from 28.4 to 19.7, while pneumonia, apoplexy and paralysis, diseases of the heart and kidneys, had increased in the same time from 17 per cent. of the total mortality to 26.3 per cent.

The effect of this upon the lifetime of the population is best shown by a quotation from a life-table, and for this purpose the following condensed table for English males is given, since it is not practicable to present a similar table for Massachusetts with accuracy, for reasons already stated. The table will answer fairly well for Massachusetts, since similar changes in the factors composing the death-rate are taking place in both communities.

For the sake of brevity the tables for males only are quoted and these only at the decennial periods, at birth, ten, twenty, thirty years, etc.

TABLE 67. — *Mean After Lifetime, or Expectation of Life (English Males).*

English Males.	1838-54.	1871-80.	1881-90.	English Males.	1838-54.	1871-80.	1881-90.
0 years, . .	39.91	41.35	43.66	60 years, .	13.53	13.14	12.88
10 years, . .	47.05	47.60	49.00	70 years, .	8.45	8.27	8.04
20 years, . .	39.48	39.40	40.27	80 years, .	4.93	4.79	4.52
30 years, . .	32.76	32.10	32.52	90 years, .	2.84	2.66	2.37
40 years, . .	26.06	25.30	25.42	100 years, .	1.68	1.61	1.24
50 years, . .	19.54	18.93	18.82				

These figures show a gain in all ages up to forty (actually to forty-four), comparing the table for 1881–90 with that of 1871–80, and a loss at the later ages of life. The table for females shows similar changes, except that the gain continues up to age forty-four, comparing the column for 1881–90 with each of the preceding tables.

The figures for Massachusetts present similar changes with those of England, so far as can be learned from the more or less crude methods which must necessarily be employed in estimating the mean after lifetime of a fluctuating population.

The following figures are introduced for the two twenty-year periods under consideration in this summary to show the principal factors which have contributed to these changes in the death-rates from different causes during these periods: —

TABLE 68. — *Death-rates from Certain Causes and Groups of Causes, 1856–95, by Five-year Periods.*

Period.	Causes.	Fall. Death-rate per 10,000 from these Causes.	Causes.	Rise. Death-rate per 10,000 from these Causes.
1856–60,	Small-pox, measles, scarlet-fever, diphtheria and croup, typhoid fever, cholera infantum, consumption, whooping-cough, dysentery and childbirth.	81.7	Pneumonia, kidney diseases, heart diseases, brain diseases and cancer.	27.7
1861–65,		93.0		34.7
1866–70,		74.8		36.6
1871–75,		84.9		44.9
Mean,	. . . .	83.5	. . . . . .	35.6
1876–80,	Small-pox, measles, scarlet-fever, diphtheria and croup, typhoid fever, cholera infantum, consumption, whooping-cough, dysentery and childbirth.	78.1	Pneumonia, kidney diseases, heart diseases, brain diseases and cancer.	46.8
1881–85,		65.1		56.7
1886–90,		56.8		62.2
1891–95,		50.5		68.8
Mean,	. . . .	60.4	. . . . . .	59.6

From the foregoing it appears that the deaths from the infectious group diminished from 81.7 (maximum 93) to 50.5 in the forty years, comparing the first five years with the last, and those of the other group of certain local causes and cancer had risen from 27.7 to 68.8 per 10,000.

The mean of the first group in the first twenty years was two and one-third times as great as that of the second group, while in the last twenty years the two means were nearly equal, 60.4 and 59.6.

The Returns of Medical Examiners.

The deaths returned by the medical examiners embrace all deaths of a violent, sudden, suspicious or doubtful character which have been referred to the medical examiners for investigation, and have been reported officially by them to the Secretary of State.

It has been customary to divide these deaths into four groups, deaths by homicide, suicide, accident or negligence, and such deaths from natural causes as have also been referred to the medical examiner in consequence of their sudden or doubtful character.

In a considerable portion of all these deaths the cause has been decided or confirmed by autopsies.

The law under which such deaths are now investigated was enacted in 1877, and substituted the present medical-examiner system in place of the old coroner's inquest, with its useless adjunct, the coroner's jury. From that time until 1885 there was no legal enactment requiring an official return of such deaths to the State authorities, but by the organization of the Massachusetts Medico-Legal Society a system of voluntary reporting was at once established, and was continued without interruption until 1885, when a law was enacted requiring such returns in all cases.

These first returns, for the period from July 1, 1877, to Dec. 31, 1884, inclusive, are incomplete, and comprise about three-fourths of the deaths of this class which were investigated during that period. From Jan. 1, 1885, onward the returns are complete, and comprise all the deaths of this class. Hence, while in the first period (1877–84) the ratio of deaths of each class to the whole number investigated may be considered as fairly accurate, the comparison with the living population can only fairly be made in the second period (1885–95).

Table 69. — *Deaths investigated by Medical Examiners.*

Voluntary Returns, Incomplete (1877–84).

Years.	Homicide.	Suicide.	Accident or Negligence.	Natural Causes.	Total.	Autopsies.	Inquests.
1877,*	51	71	206	102	430	116	99
1878,	68	92	331	328	819	196	172
1879,	54	122	322	302	800	182	152
1880,	104	118	415	340	977	229	197
1881,	66	112	396	383	957	179	189
1882,	64	117	374	336	891	189	179
1883,	46	157	571	431	1,205	215	225
1884,	45	141	469	324	979	194	204
Total,	498	925	3,084	2,551	7,058	1,500	1,417

* Six months.

TABLE 69 — *Concluded.*

Statutory Returns, Complete (1885–95).

Years.	Homicide.	Suicide.	Accident or Negligence.	Natural Causes.	Total.	Autopsies.
1885,	45	181	567	485	1,278	165
1886,	47	157	678	496	1,378	206
1887,	42	173	748	583	1,546	185
1888,	52	190	785	624	1,651	219
1889,	61	199	792	612	1,664	216
1890,	35	196	862	680	1,773	206
1891,	60	187	866	727	1,840	225
1892,	72	273	974	890	2,209	272
1893,	76	290	976	879	2,221	269
1894,	68	270	975	846	2,159	272
1895,	74	281	1,019	943	2,317	271
Total,	632	2,397	9,242	7,765	20,036	2,505

By the foregoing table it appears that during the years in which no official returns were required 7,058 deaths had been reported to the Medico-Legal Society as having been investigated by the medical examiners, of which number 498, or 7.1 per cent., were homicides, 925, or 13.1 per cent., were suicides, and 3,084, or 43.7 per cent., were deaths from accident or negligence. In the second period, when returns were obligatory and presumably complete, the whole number of deaths investigated was 20,036, of which 632, or 3.1 per cent., were homicides, 2,397, or 12.0 per cent., were suicides, and 9,242, or 46.1 per cent., were accidental deaths.

The number of autopsies returned in the first period was 1,500, or 21.3 per cent. of the whole number investigated. In the second period the autopsies were 2,505, or 12.5 per cent. of the number investigated.

In the first period, 1,417 inquests were reported as having been conducted, or 20.1 per cent. of the whole number. The number of inquests was not reported in the second period.

The foregoing figures have but little significance as to the actual ratio or death-rate from these forms of death by violence. Comparing the figures in the second period with the living population it appears that the death-rate from homicide in the eleven years 1885–95 was 0.26 per 10,000 of the living population, a slight increase having taken place, comparing the first years of the period with the last, the minimum being 0.16 in 1890, and the maximum 0.32 in 1893. From suicide * the death-rate was 0.97 per 10,000

* For further statistics upon the subject of suicide, see 46th Mass. Registration Report, 1887.

living, the minimum being 0.78 in 1886, and the maximum 1.21 in 1893. From accident the death-rate was 3.8 per 10,000, the minimum being 2.9 in 1885, and the maximum 4.1 in 1892, 1893 and 1895.

With reference to methods, out of 2,613 suicides in which the method selected was specified, 668 committed suicide by hanging, 463 by drowning, 527 by shooting, 300 by knife-wounds of the neck, and 655 by poison, the chief poisons employed being the different preparations of arsenic and of opium.

Previous to the repeal of the law limiting the percentage of carbonic oxide in illuminating gas, only 6 suicides by the use of illuminating gas had been reported, but in the seven years following the removal of this restriction 62 by this method were reported by medical examiners.

Out of 9,022 deaths by accidental means, 4,179 were railroad accidents, including those which occurred on street railways, the number of which has considerably increased since the introduction of electricity as a motive power. There were 3,169 by drowning, 1,456 by falls, blows and falling bodies, and 218 by poison.

Accidental deaths by inhaling illuminating gas had also increased very largely since the introduction of water gas.

Deaths of infants by overlaying and asphyxia in bed have also materially increased, from 64 in the five years 1886–90 to 145 in the five years 1891–95. These were nearly all infants under one year old.

Suicides.

The following summary of suicidal deaths comprises the statistics of the forty-year period 1856–95.

The whole number of such deaths in the forty years was 5,445, of which 4,271 were males and 1,174 were females. Of this number, 1,919 occurred in the first period and 3,526 in the second. This indicates a slight increase in the death-rate from this cause from 0.71 per 10,000 living annually in the first period to 0.87 in the second period.

Sex. — The increase in men was greater than that among women, that of men in the first period having been 1.14 per 10,000 and in the second 1.42, indicating an increase of 25 per cent., and that of women increasing from 0.32 to 0.35, or 10.4 per cent.

The seasonal intensity of the mortality from suicide is indicated by the following figures: —

Suicides by Months.

	Deaths.	Death-rate reduced to a Mean of 100.		Deaths.	Death-rate reduced to a Mean of 100.
January, ...	368	80	July, ...	510	110
February, ...	325	77	August, ...	467	101
March, ...	463	100	September, ...	443	99
April, ...	578	129	October, ...	432	93
May, ...	512	111	November, ...	416	93
June, ...	521	117	December, ...	409	89

Ages. — The following are the figures for ages, with the annual death-rate per 10,000 living at each age: —

Ages.	Deaths.	Death-rate.	Ages.	Deaths.	Death-rate
10-15, ...	17	0.03	50-60, ...	1,010	2.00
15-20, ...	162	0.26	60-70, ...	749	2.34
20-30, ...	904	0.78	70-80, ...	392	2.58
30-40, ...	1,023	1.07	80 and over, ...	83	1.78
40-50, ...	1,054	1.44			

Deaths by Lightning.

During the forty years 1856–95, 149 deaths were registered as having been caused by lightning. No deaths were registered as from lightning in 1861, 1864 and 1891. In the other years the deaths from this cause varied from 1 to 10 in each, 10 having been reported in 1892 and 9 in 1872.

Sex. — Of the whole number, 102, or 68.5 per cent., were males and 47, or 31.5 per cent., were females.

Seasons. — The deaths by months were as follows: —

January, ...	0	August, ...	50
February, ...	1	September, ...	6
March, ...	0	October, ...	0
April, ...	4	November, ...	0
May, ...	10	December, ...	1
June, ...	24		
July, ...	53	Total, ...	149

Eighty-five per cent. of the whole number occurred in the three summer months.

Ages. — The deaths by ages were as follows: —

Under 5,	4	50,	14
5,	12	60,	9
10,	13	70,	5
15,	19	80,	4
20,	34	Unknown,	1
30,	17		
40,	17	Total,	149

Vital Statistics of Cities, 1894 and 1895.

In Table 70 (page 826) are presented the most important items of vital statistics in the cities and large towns having more than 10,000 inhabitants for the two years 1894 and 1895. Of these there were 39 in 1895, having a total population of 1,719,680, or 68.8 per cent. of the population of the State. This urban population may be divided into four groups, as follows: —

		Population.
Group I.	One city having a population of more than 100,000,	496,920
		Total Population.
Group II.	Nine cities having populations of more than 50,000 and less than 100,000 in each,	627,471
Group III.	Ten cities having more than 25,000 and less than 50,000 in each,	308,466
Group IV.	Nineteen cities and towns having more than 10,000 and less than 25,000 in each,	286,823

In nearly every particular these groups are found to bear a direct relation to the density of population in the different groups.

By groups the principal data were as follows: —

	Per 1,000.			Death-rates per 10,000 from —						
	Marriage-rate.	Birth-rate.	Death-rate.	Consumption.	Pneumonia.	Typhoid Fever.	Diphtheria and Croup.	Measles.	Scarlet-fever.	Cholera Infantum.
Group I.,	23.1	31.2	23.2	31.5	24.7	3.1	15.6	0.5	3.2	10.9
Group II.,	18.9	29.7	19.5	20.8	17.1	3.1+	6.2	0.6	2.9	14.8
Group III.,	18.1	29.0	18.0	20.1	15.2	2.4	6.8	0.5	1.6	9.5
Group IV.,	15.9	27.6	16.7	19.1	14.1	3.3	5.8	0.3	2.1	8.9

The cities and large towns having the highest and lowest rates were as follows: —

Marriage-rates (Persons Married), 1894–95.

The State = 17.7.

	Highest.		Lowest.
Chicopee,	27.3	Woburn,	13.9
Boston,	23.1	Medford,	13.2
Lawrence,	22.1	Marlborough,	13.1
New Bedford,	21.9	Quincy,	12.8
Lowell,	21.4	Peabody,	12.6

Birth-rates per 1,000 Inhabitants, 1894–95.

The State = 27.2.

Holyoke,	40.9	Northampton,	23.7
Chicopee,	37.2	Brockton,	22.9
Everett,	32.9	Newburyport,	22.7
Fitchburg,	32.9	Weymouth,	22.0
North Adams,	32.5	Beverly,	19.1

Death-rates per 1,000, 1894–95.

The State = 19.1.

Boston,	23.2	Waltham,	15.0
Fall River,	22.8	Fitchburg,	15.0
Lowell,	21.9	Hyde Park,	15.0
Chelsea,	21.7	Brookline,	14.1
Chicopee,	21.4	Melrose,	13.8

Natural Growth.

The natural growth is indicated by the excess of the birth-rate over the death-rate.

	Highest.		Lowest.
Holyoke,	21.5	Taunton,	5.7
Fitchburg,	17.9	Gloucester,	5.7
Everett,	17.1	Weymouth,	5.2
Chicopee,	15.8	Newburyport,	4.4
North Adams,	15.7	Beverly,	3.5

Infantile Death-rates, Percentage of Births, 1894–95.

The State = 16.0.

	Highest.		Lowest.
Fall River,	26.7	Brookline,	10.9
Chicopee,	21.5	Gloucester,	10.7
Lowell,	20.5	Westfield,	10.5
New Bedford,	19.6	Peabody,	10.4+
Lawrence,	19.4	Malden,	10.4

Death-rate from Consumption per 10,000 Inhabitants, 1894–95.

The State = 22.1.

Boston,	31.5	Salem,	15.1
Chelsea,	29.4	Newton,	14.9
Weymouth,	28.4	North Adams,	14.6
Marlborough,	24.2	Fitchburg,	13.9
Cambridge,	24.2	Westfield,	11.3

Death-rate from Pneumonia, 1894–95.

The State = 17.7.

Boston,	24.7	Brookline,	10.5
Haverhill,	21.6	Quincy,	10.4
Chicopee,	19.5	Fitchburg,	10.0
Lawrence,	19.2	Pittsfield,	9.9
Worcester,	19.0	Melrose,	8.2

Death-rate from Typhoid Fever, 1894–95.

The State = 2.9.

North Adams,	11.4	Northampton,	1.8
Lowell,	5.0	Hyde Park,	1.7
Woburn,	5.0	Chelsea,	1.6
Newburyport,	4.8	Brookline,	1.3
Clinton,	4.4	Gloucester,	1.3

Death-rate from Diphtheria and Croup, 1894-95.

The State = 7.2.

	Highest.		Lowest.
Boston,	15.6+	Haverhill,	2.8
Taunton,	15.6	Marlborough,	2.7
Chelsea,	12.4	Fitchburg,	2.5
Quincy,	11.8	Northampton,	2.1
Cambridge,	10.8	Newburyport,	1.4

Four cities having the highest death-rates from diphtheria and croup were in the metropolitan district.

Death-rate from Measles, 1894-95.

The State = 0.4.

	Highest.		Highest.
Holyoke,	3.1	Chicopee,	1.5
Springfield,	2.1	Fall River,	0.9
Northampton,	1.7		

The 4 cities having the highest death-rate from measles were in close communication on one line of railway in the Connecticut valley, and there were 17 cities and large towns, containing over 250,000 inhabitants, in which no deaths from this cause were registered in 1894 and 1895. There were also 7 other cities in which only one death from measles occurred in each.

Death-rate from Scarlet-fever, 1894-95.

The State = 2.3.

	Highest.		Lowest.
Woburn,	13.1	Peabody,	0.5
Somerville,	7.3	Fitchburg,	0.4
Cambridge,	7.0	Holyoke,	0.2
Medford,	4.2	Beverly,	0.0
North Adams,	3.4	Clinton,	0.0

In one city and one town there were no deaths from scarlet-fever.

Death-rate from Cholera Infantum, 1894–95.

The State = 10.2.

	Highest.		Lowest.
Lowell,	26.2	Haverhill,	5.5
Chicopee,	25.0	Beverly,	5.1
Fall River,	24.4	Medford,	4.6
Lawrence,	19.6	Waltham,	4.4
Holyoke,	15.3	Weymouth,	3.6

The first five are manufacturing cities.

The cities and towns which had the highest and lowest combined death-rate from these seven infectious diseases were as follows, in the order named: —

Combined Death-rates from Specified Diseases, 1894–95.

The State = 62.9.

	Highest.		Lowest.
Boston,	89.6	Northampton,	43.5
Chicopee,	77.2	Medford,	43.2
Lowell,	76.1	Fitchburg,	41.8
Fall River,	73.2	Melrose,	41.3
Cambridge,	71.8	Brookline,	40.3

The following table contains the principal vital statistics of the cities and large towns having over 10,000 inhabitants in each for the two years 1894 and 1895: —

TABLE 70. — *Population, Marriages, Births, Deaths, Deaths under One Year and Death-rates from Certain Diseases in Two Years, 1894 and 1895, in Cities and Towns having over 10,000 Inhabitants, in Massachusetts.*

[The marriage, birth and general death rates are expressed as a ratio per ,000, those of certain diseases as a ratio per 10,000, of the living population, and the deaths of infants under one year old as a percentage of the births.]

Number.	Cities and Towns.	Population, 1895.	Marriages.	Marriage-rate, Persons Married.	Births.	Birth-rate.	Deaths.	Death-rate.	Deaths under One Year.	Percentage of Births.	Deaths from Consumption.	Death-rate.	Number.
1	Boston, ...	496,920	11,368	23.10	30,759	31.24	22,887	23.25	5,132	16.70	3,101	31.52	1
2	Worcester, ...	98,767	1,629	16.72	5,773	29.66	3,660	18.92	753	13.04	439	22.21	2
3	Fall River, ...	89,203	1,771	20.21	5,655	31.60	3,994	22.79	1,461	26.74	351	19.89	3
4	Lowell, ...	84,367	1,791	21.40	5,408	32.28	3,659	21.86	1,107	20.40	349	20.79	4
5	Cambridge, ...	81,643	1,289	16.01	4,631	30.04	3,150	19.59	696	14.45	399	24.19	5
6	Lynn, ...	62,354	1,269	20.42	3,252	26.37	1,997	16.19	422	12.98	239	19.33	6
7	New Bedford, ...	55,251	1,172	21.36	3,454	32.21	2,131	19.87	676	19.56	236	22.01	7
8	Somerville, ...	52,200	817	16.06	2,789	27.41	1,711	16.88	347	12.44	218	20.94	8
9	Lawrence, ...	52,164	1,136	22.12	2,900	28.23	2,021	19.67	569	19.41	201	19.57	9
10	Springfield, ...	51,522	895	17.64	2,736	26.96	1,720	16.95	385	14.07	182	17.94	10
11	Holyoke, ...	40,322	729	18.30	3,299	40.91	1,542	19.36	-	-	190	23.55	11

23	Pittsfield,	20,461	306	15.21	1,066	24.50	631	15.68	135	12.66	79	19.63	23
24	North Adams,	19,135	321	17.05	1,224	32.50	634	16.84	157	12.83	55	14.61	24
25	Everett,	18,573	298	16.44	1,174	32.94	566	15.88	163	13.88	66	18.52	25
26	Northampton,	16,746	274	16.54	785	23.69	520	15.69	106	13.50	58	17.50	26
27	Chicopee,	16,420	442	27.35	1,206	37.23	692	21.38	259	21.49	68	21.01	27
28	Brookline,	16,164	248	15.42	763	24.21	444	14.09	83	10.88	49	15.55	28
29	Marlborough,	14,977	195	13.12	815	27.43	523	17.60	137	16.81	72	24.23	29
30	Newburyport,	14,552	262	18.08	657	22.67	530	18.29	105	15.98	53	18.29	30
31	Medford,	14,474	186	13.16	736	26.04	430	15.21	87	11.82	44	15.57	31
32	Woburn,	14,178	196	13.89	884	31.33	603	21.37	147	16.63	52	18.43	32
33	Melrose,	11,965	186	16.01	581	25.00	321	13.81	70	12.05	38	16.35	33
34	Hyde Park,	11,826	170	14.58	594	25.47	350	15.00	107	18.01	41	17.58	34
35	Beverly,	11,806	169	14.43	448	19.13	367	15.67	29*	12.72	41	17.51	35
36	Clinton,	11,497	218	19.14	696	30.56	393	17.25	87	12.50	43	18.88	36
37	Weymouth,	11,291	178	15.82	495	22.00	377	16.76	69	13.94	64	28.45	37
38	Westfield,	10,663	175	16.55	514	24.30	343	16.21	54	10.50	24	11.35	38
39	Peabody,	10,507	134	12.79	537	25.64	399	19.05	28*	10.43	47	22.44	39
	Totals, urban,†	1,719,680	33,018	19.47	100,641	29.67	67,320	19.85	15,676	15.58	7,972	23.50	
	Totals, rural,†	780,508	10,703	13.77	33,820	21.76	27,011	17.38	5,787	17.11	2,977	19.15	
	Totals, the State,	2,500,183	43,721	17.68	134,481	27.19	94,331	19.07	21,463	15.96	10,949	22.14	
	Over 100,000,	496,920	11,363	23.10	30,739	31.24	22,857	23.23	5,132	16.69	3,101	31.52	
	Less than 100,000 and over 50,000,	627,471	11,658	18.89	36,676	29.72	24,063	19.49	6,432	17.54	2,571	20.83	
	Less than 50,000 and over 25,000,	308,466	5,501	18.08	17,649	29.00	10,974	18.03	2,022	11.45	1,224	20.12	
	Less than 25,000 and over 10,000,	286,823	4,496	15.92	16,577	27.57	9,426	16.68	2,090	13.42	1,076	19.05	

* One year.

† The terms "urban" and "rural" as here employed refer to the 39 cities and towns enumerated in this table for the "urban" class, and to the remaining population for the "rural."

NOTE. — The population stated in this table is that of the State Census of 1895, but the mean population employed for computing the marriage, birth and death rates, etc., is obtained by estimating the population of each city and town for the year 1894, upon the rate of growth from 1890 to 1895, and then taking a mean of the two years 1894 and 1895.

TABLE 70 — *Concluded.*

Number.	CITIES AND TOWNS.	Deaths from Pneumonia.	Death-rate.	Deaths from Typhoid Fever.	Death-rate.	Deaths from Diphtheria and Croup.	Death-rate.	Deaths from Measles.	Death-rate.	Deaths from Scarlet-fever.	Death-rate.	Deaths from Cholera Infantum.	Death-rate.	Total Deaths Principal Infectious Diseases.	Death-rate per 10,000.	Number.
1	Boston, ...	2,436	24.73	301	3.06	1,580	16.01	49	0.50	317	3.22	1,079	10.97	8,816	89.6	1
2	Worcester, . . .	370	19.02	57	2.93	140	7.20	15	0.77	13	0.67	202	10.38	1,229	63.2	2
3	Fall River, . . .	306	17.40	60	3.42	104	5.94	16	0.91	56	3.17	427	24.37	1,282	73.2	3
4	Lowell, ...	292	17.45	84	5.02	88	5.26	1	0.06	21	1.25	439	26.23	1,275	76.1	4
5	Cambridge, . . .	264	16.42	41	2.55	173	10.76	3	0.19	113	7.03	171	10.63	1,154	71.8	5
6	Lynn, ...	151	12.24	26	2.11	65	5.27	4	0.32	33	2.68	77	6.24	505	46.3	6
7	New Bedford, . . .	162	15.07	24	2.24	50	4.66	2	0.19	25	2.33	137	12.76	656	61.2	7
8	Somerville, . . .	130	17.00	25	2.46	61	7.96	2	0.20	74	7.27	66	6.68	643	63.2	8
9	Lawrence, . . .	197	19.16	43	4.19	30	2.92	4	0.39	31	3.02	201	19.57	707	68.8	9
10	Springfield, . . .	168	16.55	25	2.46	31	3.06	21	2.07	13	1.28	111	10.94	561	54.3	10
11	Holyoke, ...	121	15.19	21	2.64	34	4.27	25	3.14	2	0.25	123	15.81	515	64.7	11
12	Salem, ...	106	16.40	18	2.79	30	4.40	1	0.15	18	2.64	90	13.20	366	53.7	12
13	Brockton, . . .	122	18.76	19	2.93	31	4.76	-	-	14	2.15	37	5.69	357	54.9	13
14	Chelsea, ...	99	16.01	10	1.62	77	12.46	2	0.32	18	2.91	52	8.58	441	71.?	14

25	Everett,	50	14.03	9	2.52	20	5.61	-	-	11	3.09	20	5.61	176	49.4	25
26	Northampton,	35	10.56	6	1.81	7	2.11	5	1.69	2	0.60	31	9.35	144	43.5	26
27	Chicopee,	63	19.47	7	2.16	21	6.49	5	1.54	5	1.54	81	25.03	250	77.2	27
28	Brookline,	33	10.47	4	1.27	21	6.66	-	-	2	0.63	18	5.71	127	40.3	28
29	Marlborough,	56	18.84	10	3.36	8	2.69	1	0.34	2	0.67	34	11.44	183	61.6	29
30	Newburyport,	40	13.80	14	4.83	4	1.38	-	-	4	1.38	21	7.25	136	46.9	30
31	Medford,	35	12.38	6	2.12	12	4.25	-	-	12	4.25	13	4.60	122	43.2	31
32	Woburn,	46	16.30	14	4.96	26	9.21	-	-	37	13.11	27	9.57	202	71.6	32
33	Melrose,	19	8.18	7	3.01	17	7.31	-	-	2	0.86	13	5.59	96	41.3	33
34	Hyde Park,	31	13.29	4	1.71	10	4.29	1	0.43	2	0.86	16	6.86	105	45.0	34
35	Beverly,	35	14.95	5	2.13	21	8.97	-	-	-	-	12	5.12	114	48.7	35
36	Clinton,	29	12.73	10	4.39	13	5.71	4	0.17	-	-	15	6.59	114	50.0	36
37	Weymouth,	27	12.00	6	2.67	12	5.33	-	-	4	1.78	8	3.56	121	53.8	37
38	Westfield,	37	17.49	7	3.31	13	6.15	-	-	4	1.89	28	13.24	113	53.4	38
39	Peabody,	34	16.23	5	2.39	17	8.12	-	-	1	0.48	20	9.55	124	59.2	39
	Totals, urban,	6,261	18.46	1,020	3.01	3,040	8.96	166	0.49	891	2.63	3,991	11.77	23,341	68.8	
	Totals, rural,	2,492	16.03	408	2.62	545	3.51	49	0.32	241	1.55	1,062	6.83	7,774	50.0	
	Totals, the State,	8,753	17.70	1,428	2.89	3,585	7.25	215	0.43	1,132	2.29	5,053	10.22	31,115	62.9	
	Over 100,000,	2,433	24.73	301	3.06	1,536	15.61	49	0.50	317	3.22	1,079	10.97	8,816	89.6	
	Less than 100,000 and over 50,000.	2,110	17.10	385	3.12	762	6.17	68	0.55	361	2.92	1,833	14.85	8,090	65.5	
	Less than 50,000 and over 25,000.	923	15.17	146	2.40	414	6.80	31	0.51	95	1.56	576	9.47	3,409	56.0	
	Less than 25,000 and over 10,000.	795	14.07	188	3.33	328	5.81	18	0.32	118	2.09	503	8.90	3,026	53.6	

STATISTICAL SUMMARIES

OF

DISEASE AND MORTALITY.

STATISTICAL SUMMARIES OF DISEASE AND MORTALITY.

The statistical information received by the Board during each year, either through the medium of voluntary returns or in consequence of legal requirements, has, in the last two reports of the Board, been presented under four different heads or groups, which were summarized and defined in the last report as follows: —

1. *The Weekly Mortality Returns.* — These consist of the reports of deaths, which are made up weekly and are sent to the office of the State Board by the registration officials of cities and towns. They are voluntary, and serve principally to show the seasonal prevalence of each of the chief infectious diseases, and the mortality of children under five years old in weekly periods. This series of statistics has been continued by the Board for at least twenty years, and has been published as a summary for fourteen years.
2. *The Reports of Certain Infectious Diseases, — Diphtheria and Croup, Scarlet-fever, Typhoid Fever and Measles.* — These are obtained from the annual reports of local boards of health for the year 1896, which are forwarded to the State Board from cities and towns. By comparing the numbers of reported cases with the reported deaths, the mean fatality of each disease in the places from which the reports are made is obtained with a reasonable degree of accuracy.
3. *Reports of Cities and Towns, made under the Provisions of Chapter 302 of the Acts of 1893.* — By this act each local board of health is required to report to the State Board every case of "disease dangerous to the public health" which is reported to the local board. A digest of these reports is presented in summary No. III.
4. *Reports made under the Provisions of Chapter 218 of the Acts of 1894.* — The full reports of deaths occurring in each city and town having over 5,000 inhabitants comprise another series of returns, which are summarized in No. IV. These reports are made under the requirements of the following statute: —

[ACTS OF 1894, CHAPTER 218, SECTION 3.]

"In each city and town having a population of more than five thousand inhabitants, as determined by the last census, at least one member of said board shall be a physician, and the board shall send an annual report of the deaths in such town to the State Board of Health. The form of such reports shall be prescribed and furnished by the State Board of Health."

I.

SUMMARY OF THE WEEKLY MORTALIT CITIES AND TOWNS.

The following summary comprises the retur the end of each week by the town clerks, city officials having in charge the vital statistics of

These returns are compiled each week and pu one copy of which is sent to the registering of town in the State. These reports are necessa they are voluntary, and comprise the mortality the population only, the reporting places being larger towns. The value of the weekly mort very largely in the fact that they constitute a the prevalence of the principal infectious dis State, so far as can be learned from the mortal

In connection with the results of the infor consequence of the enactment of chapter 302 these weekly mortality reports furnish to the index of the health of the people, as influenc of epidemic diseases at different seasons of the population of the cities and towns contributi 1896 was about 1,486,000, or about three-fif lation.

The data embraced in this summary are the following:—

Average height of barometer for each week.
Mean maximum temperature.
Mean minimum temperature.
Rainfall expressed in inches.
Total deaths reported for each week.
Deaths of children under five years.
Deaths from infectious diseases.
Deaths from consumption.
Deaths from acute lung diseases.
Deaths from typhoid fever.
Deaths from diarrhœal diseases.
Deaths from scarlet-fever.
Deaths from measles.
Deaths from diphtheria and croup.
Deaths from puerperal fever.
Deaths from whooping-cough.
Deaths from malarial fever.
Deaths from small-pox.
Deaths from erysipelas.

In consequence of the unusual amount of space devoted to the vital statistics of the State in this report, the usual summary of the facts contained in the following table will be omitted this year, but will be presented, together with that of other years, as a general summary in a succeeding volume.

The following table contains a summary of the statistics compiled from these weekly returns of mortality:—

Summary.

Date.	Barometer.	Maximum Thermometer Mean for Each Week.	Minimum Thermometer Mean for Each Week.	Rain (Inches).*	Humidity.	Total Deaths.	Deaths under Five Years of Age.	Consumption.	Acute Lung Diseases.	Typhoid Fever.	Diphtheria and Croup.	Scarlet-fever.	Measles.	Diarrhoeal Diseases.	Whooping-cough.	Malarial Fever.	Puerperal Fever.	Erysipelas.	Cerebro-spinal Meningitis.	Small-pox.
Jan. 4,	29.90	37	29	–	78	563	169	58	89	8	31	3	–	5	11	–	–	1	6	–
11,	30.23	21	7	–	63	519	130	59	82	6	31	–	–	3	–	–	–	1	2	–
18,	30.20	33	10	–	73	583	163	60	115	8	32	2	–	2	6	–	1	3	2	–
25,	30.21	33	25	1.70	84	673	169	70	93	6	32	1	–	3	5	–	–	4	5	–
Feb. 1,	30.13	34	23	–	72	621	132	61	71	9	30	3	–	6	1	–	2	–	5	–
8,	29.59	40	23	–	62	698	157	62	107	8	22	–	1	10	4	–	–	1	4	–
15,	29.79	35	30	–	70	677	166	60	94	6	25	6	2	4	1	–	3	2	7	–
22,	29.99	27	24	–	71	590	177	65	107	7	45	4	1	7	8	–	–	–	1	–
29,	29.85	42	8	6.15	66	612	155	69	113	5	20	2	1	7	1	–	–	–	7	–
March 7,	29.64	34	22	–	80	654	161	63	117	6	30	5	1	5	2	1	–	5	5	–
14,	29.85	23	23	–	66	589	165	58	114	7	15	4	–	8	2	–	2	1	6	–
21,	29.99	43	20	–	73	647	184	65	110	8	21	10	1	8	3	–	–	–	5	–
28,	30.13	43	27	1.66	66	667	202	58	107	3	19	6	1	6	4	–	–	1	4	–
April 4,	29.58	42	25	–	69	640	185	76	135	4	20	8	1	1	4	–	–	–	7	–
11,	30.28	47	32	–	62	605	178	103	122	5	18	4	1	3	2	–	–	2	4	–
18,	30.04	70	32	–	70	660	196	54	121	6	22	3	2	11	10	–	–	–	6	–
25,	30.05	60	44	1.24	69	652	178	68	146	7	24	7	2	9	4	1	2	1	8	–
May 2,	30.27	55	41	–	56	572	169	53	124	2	17	–	3	8	2	–	–	5	1	–
9,	30.08	66	48	–	64	621	176	75	107	4	21	2	–	13	4	–	–	5	3	–
16,	29.92	75	54	–	69	625	206	61	118	7	21	5	1	6	3	1	–	4	4	–

Sept. 5,	30.07	72	54	–	67	541	237	54	30	7	21	–	–	96	5	–	–	–	8	–
12,	29.98	73	60	–	86	604	244	60	48	14	16	–	–	113	4	–	–	1	6	–
19,	29.95	69	56	–	85	605	211	46	35	23	24	1	–	64	9	–	–	2	5	–
26,	30.10	66	49	7.21	69	543	228	57	40	12	20	2	1	51	2	–	–	–	4	–
Oct. 3,	30.05	66	54	–	83	544	197	60	41	16	23	4	–	68	2	–	–	1	2	–
10,	30.24	53	43	–	74	464	156	62	38	13	28	–	–	26	3	–	–	1	3	–
17,	29.89	54	44	–	80	533	205	59	66	19	34	1	1	21	1	–	1	–	1	–
24,	29.93	56	40	–	74	472	149	56	44	17	27	3	1	14	8	–	1	1	4	–
31,	30.14	62	46	3.18	67	500	157	53	62	17	30	4	4	12	2	–	–	–	2	–
Nov. 7,	30.06	61	45	–	78	495	158	50	56	15	40	3	1	10	4	–	–	1	2	–
14,	30.02	52	39	–	78	478	158	43	63	15	52	3	2	13	1	–	–	2	3	–
21,	30.22	54	35	–	72	442	144	30	47	9	38	5	3	8	1	–	–	–	7	–
28,	30.56	56	38	3.10	88	504	162	65	65	9	34	7	2	11	1	1	–	2	4	–
Dec. 5,	30.37	34	23	–	77	475	145	35	48	12	26	3	–	11	5	–	1	2	5	–
12,	29.99	50	37	–	73	502	153	54	112	6	19	9	3	6	2	1	–	2	3	–
19,	29.97	40	23	–	66	524	171	47	98	6	25	3	1	9	1	–	–	1	4	–
26,	30.09	27	15	–	60	504	142	44	79	6	23	12	4	4	5	–	–	2	5	–
Jan. 2,	30.55	38	20	1.77	65	604	170	65	110	9	31	2	4	6	2	–	–	4	5	–
Totals,	–	–	–	37.71	–	30,802	10,977	3,243	3,069	450	1,280	190	74	2,736	171	6	17	70	221	–
Weekly averages,	–	–	–	–	–	581	207	61	75	9	23	4	1	52	3	–	–	1	4	–
Rate per 1,000 deaths,	–	–	–	–	–	–	356.4	105.3	128.8	14.6	39.9	6.17	2.40	88.80	5.55	.19	.55	2.27	7.17	–
Rate per 1,000 population,	–	–	–	–	–	20.7	7.39	2.19	2.67	.30	.85	.13	.05	1.84	.12	–	–	–	.15	–

Average reporting population, ... 1,456,000

* The figures in this column represent the rainfall by months.

II.

FATALITY (*RATIO OF DEATHS TO CASE* INFECTIOUS DISEASES IN

The statistics presented in the following tab the published reports of local boards of healt which have been forwarded to the office of the S They are the figures representing the numbers local boards of health under the provisions of s 80, Public Statutes.

The numbers of deaths are also obtained fro and the comparison of these two series of figu accurate method of arriving at the fatality from places from which they are reported. The fig numbers of cases are probably less than the a some cases must necessarily escape registratio report or in consequence of faulty diagnosis.

Cases of Infectious Diseases and Deaths reported to Local

City or Town.	Diphtheria and Croup.		Scarlet-Fever.	
	Cases.	Deaths.	Cases.	Deaths.
Athol,	6	-	4	-
Amesbury,	38	2	23	-
Adams,	51	12	2	-
Attleborough,	10	2	4	-
Ayer,	5	2	16	-
Belmont,	4	-	6	-
Blackstone,	5	3	4	-
Boston,	4,490	672	1,216	121
Brookfield,	-	-	-	-
Brookline,	53	6	27	2
Cambridge, †	455	62	196	6
Canton,	1	-	5	-
Chelsea,	100	27	32	2

* An epidemic, number not stated. † Cerebro-spinal me

Cases of Infectious Diseases, etc. — Continued.

City or Town.	Diphtheria and Croup.		Scarlet-fever.		Typhoid Fever.		Measles.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Chicopee, ...	92	25	36	4	-	-	-	-
Clinton, ...	16	-	34	2	17	-	11	-
Concord,*	4	-	3	-	7	1	-	-
Cottage City, ...	7	-	-	-	3	-	1	-
Danvers, ...	9	2	17	-	5	-	31	-
Dedham, ...	15	3	4	-	10	2	16	-
Easthampton, ...	-	-	3	-	-	-	-	-
East Bridgewater, ...	-	-	12	1	-	-	-	-
Everett, ...	90	7	9	-	26	6	241	4
Fall River, ...	130	71	208	20	95	25	-	-
Fitchburg, ...	42	18	49	2	29	4	36	-
Framingham, †	22	3	13	-	11	-	14	-
Franklin, ...	9	-	4	-	3	-	1	-
Gardner, ...	11	2	8	3	12	5	-	-
Gloucester, ...	75	13	135	5	43	9	-	-
Haverhill, ...	76	18	47	4	121	18	62	-
Hull, ...	2	-	1	-	-	-	1	-
Ipswich, ...	54	8	6	-	24	3	-	-
Lee, ...	1	1	6	-	5	-	-	-
Leicester, ...	15	-	13	-	7	-	1	-
Leominster, ...	21	6	138	1	9	-	5	-
Lexington, ...	5	-	4	-	5	1	24	-
Lincoln, ...	1	-	-	-	9	2	-	-
Lowell, ...	110	47	76	1	178	36	346	3
Lynn, ...	426	62	227	4	99	27	-	-
Malden, ...	92	7	42	4	74	5	45	1
Manchester, ...	7	-	11	-	-	-	-	-
Marlborough, ‡	20	4	12	-	13	1	95	1
Medfield, ...	6	-	4	-	3	-	6	-
Medford, ...	109	11	32	-	23	3	217	1
Melrose, ...	19	3	25	1	9	2	22	-
Milford, ...	50	4	10	1	5	1	-	-
Millbury, ...	9	1	11	1	3	-	14	-
Nahant, ...	1	1	1	-	-	-	-	-
Natick, ...	13	1	14	-	4	2	8	-

* Cerebro-spinal meningitis, 1 death. † Cerebro-spinal meningitis, 3 deaths.
‡ Cerebro-spinal meningitis, 2 deaths; 1 case of small-pox.

Cases of Infectious Diseases, etc. — Con

City or Town.	Diphtheria and Croup.		Scarlet-fever.	
	Cases.	Deaths.	Cases.	Deaths.
New Bedford,*	70	33	79	3
Newton,†	174	21	66	1
Northampton,	19	4	20	–
North Adams,‡	35	5	26	–
North Andover,	9	3	3	–
North Attleborough,	12	4	4	–
Norwood,	16	–	23	–
Pittsfield,	117	14	9	–
Palmer,	13	5	2	–
Plymouth,	4	–	56	2
Quincy,	112	10	66	–
Revere,	24	2	9	–
Salem,	206	21	150	8
Sharon,	2	–	–	–
Somerville,	430	65	142	5
Springfield,	93	26	33	3
Swampscott,	5	2	5	–
Taunton,	61	12	12	–
Tewksbury,	10	1	1	–
Wakefield,	28	1	6	–
Waltham,§	75	8	34	4
Warren,	8	3	27	–
Watertown,‖	38	7	36	–
Ware,	15	7	4	–
Wellesley,	2	–	1	–
Westfield,	22	6	12	–
Whitman,	8	1	19	1
Winchester,	94	7	10	–
Woburn,	56	5	37	2
Worcester,	252	70	224	6
Totals,	8,915	1,348	3,673	230
Fatality, per cent.,	15.1		6.7	

* Whooping-cough, 19 cases. Cerebro-spinal

‡ German measles, 6 cases; chicken-pox, 4 cases mumps, 1 ca

§ Small pox, 2 cases. ‖ Whooping-cou

The cities and towns embraced in the foregoing table are 78 in number, or 6 less than those presented in the previous year. They comprise at least three-fourths of the population of the State.

The reported cases from diphtheria and croup were in excess of those of any of the previous years embraced in the report, but the actual number of deaths was less than that of either of the two preceding years and the fatality was also less, being only 15.1. Comment upon these figures will be found elsewhere.

The reported cases of scarlet-fever were much less than those reported in 1895, and the fatality (5.7 per cent.) was less.

The reported cases of typhoid fever were greater than those of 1895, and the fatality (15.6) was less than that recorded in any previous year.

The reported cases of measles were in greater number than those of any previous year, but the fatality (0.9) was less.

The figures for 1896 are as follows: —

Reported cases of diphtheria and croup,	8,915
Registered deaths from diphtheria and croup in the same cities and towns,	1,348
Fatality (per cent.),	15.1
Reported cases of scarlet-fever,	3,873
Registered deaths from scarlet-fever in the same cities and towns,	220
Fatality (per cent.),	5.7
Reported cases of typhoid fever,	3,016
Registered deaths from typhoid fever in the same cities and towns,	471
Fatality (per cent.),	15.6
Reported cases of measles,	6,861
Registered deaths from measles in the same cities and towns,	65
Fatality (per cent.),	0.9

The following table presents the summary of these statistics for the five years 1891–1896: —

Reported Cases of Infectious Diseases in Massachusetts.

Diphtheria and Croup.

[Pre-Antitoxin Period.]

	1891.	1892.	1893.	1894.	Total.
Reported cases,	2,444	3,038	2,919	4,936	13,332
Deaths,	575	891	926	1,376	3,768
Fatality (per cent.),	23.5	29.2	31.7	27.9	28.3

Reported Cases of Infectious Diseases in Massachu

Diphtheria and Croup.

[Antitoxin Period.]

Reported cases, ...	
Deaths, ...	
Fatality (per cent.), ...	

Scarlet-fever.

	1891.	[illegible]	[illegible]
Reported cases, ...	4,517	6,112	7,420
Deaths, ...	151	201	604
Fatality (per cent.), ...	3.3	4.0	8.0

Typhoid Fever.

	1891.	1892.	1893.
Reported cases, ...	2,414	1,808	2,457
Deaths, ...	460	[illegible]	492
Fatality (per cent.), ...	19.0	23.0	20.0

Measles.

	1891.	1892.	1893.
Reported cases, ...	5,861	763	6,290
Deaths, ...	84	31	98
Fatality (per cent.), ...	1.4	4.0	1.6

For the purpose of convenience in future refe
ing to diphtheria and croup is here divided int
may properly be called the pre-antitoxin and t
since antitoxin came into use in the State abo
the year 1895.

In order to compare the foregoing figures w
country in which systematic notification has b

period of several years successively, the following figures for England are also presented, as given in the annual reports of the Local Government Board: —

England.

[Local Government Board figures.]

	Diphtheria.		Croup.		Total.		Per Cent.
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	
1890, ...	-	-	-	-	2,953	753	25.5
1891, ...	-	-	-	-	11,919	2,829	23.7
1892, ...	13,977	3,177	1,169	401	15,146	3,578	23.6
1893, ...	20,712	4,751	1,436	685	22,148	5,436	24.5
1894, ...	17,581	4,236	1,256	486	18,837	4,722	25.1
1895, ...	18,700	4,225	1,263	540	19,963	4,765	23.9
Total, ...	70,970	·16,389	5,124	2,112	90,966	22,083	-
Mean fatality (per cent.), .	23.1		41.2		24.3		24.3

The following figures present the fatality from diphtheria and croup, scarlet-fever and typhoid fever in England, as reported by the Local Government Board of England for the years 1890–95: —

	1890.	1891.	1892.	1893.	1894.	1895.
Diphtheria and croup, ...	25.5	23.7	23.6	24.5	25.1	23.9
Scarlet-fever, ...	8.0	5.8	4.4	4.2	4.8	4.2
Typhoid fever, ...	19.9	20.8	17.8	17.0	17.5	16.9

III.

Official Returns of Notified Diseases Dang
Health, 1896.

The following summary embraces the returns ous to public health," made to the State Board provisions of chapter 302 of the Acts of 189 question did not specify the diseases intended Board (except small-pox), the Board issued a expressed its opinion as to the particular dise reported under the provisions of this act. The *small-pox*, *scarlet-fever*, *measles*, *typhoid feve branous croup*, *cholera*, *yellow fever*, *typhus meningitis*, *hydrophobia*, *malignant pustule*, *le*

The report of 1893 embraced the returns o only which immediately followed the enactment those of 1894 and 1895 were each for a full yea

The whole number of cases of infectious dise was 21,320, which were divided as follows: —

Reported cases of small-pox,	
Reported cases of diphtheria and croup,	
Reported cases of scarlet-fever,	
Reported cases of typhoid fever,	
Reported cases of measles,	
Total,	

The summary for the years 1893, 1894, 189 lows: —

	Reporte		
	Small-pox.	Diphtheria and Croup.	Sc fe
1893 (four months only),	35	1,369	2
1894,	[illegible]	4,178	6
1895,	1	7,606	6
1896,	5	8,515	3
Total,	222	21,668	[illegible]

Seasonal Distribution. — By months these diseases were reported as follows in 1896: —

Cases of Infectious Diseases reported to the Board by Months during 1896.

	Diphtheria.	Scarlet-fever.	Typhoid Fever.	Measles.		Diphtheria.	Scarlet-fever.	Typhoid Fever.	Measles.
January, ...	896	407	144	346	August, . . .	525	[redacted]	221	177
February, . . .	764	315	92	487	September, . .	584	190	409	207
March, ...	845	370	72	455	October, . . .	1,041	290	609	345
April, ...	506	334	65	461	November, . .	910	416	346	532
May, ...	737	312	106	965	December, . .	821	400	222	1,073
June, ...	621	332	114	942	Total, . .	8,515	3,801	2,687	6,362
July, ...	516	206	136	479					

In order that the foregoing figures may be interpreted with greater facility the following table is appended: —

Intensity of Prevalence.

	Diphtheria and Croup.			Scarlet-fever.			Typhoid Fever.			Measles.		
	[redacted]		1895.	1896.		1895.	1896.		1895.	1896.		1895.
	A	B	B	A	B	B	A	B	B	A	B	B
January, . .	29.0	12.4	9.5	13.1	12.6	14.9	4.6	6.4	6.4	11.2	6.4	6.3
February, . .	26.3	11.3	9.3	10.9	10.5	13.6	3.2	4.4	3.1	15.1	5.7	6.1
March, . . .	20.8	8.9	7.8	11.9	11.4	14.3	2.3	3.2	3.1	14.7	8.4	16.6
April, . . .	16.9	7.3	5.3	11.1	10.7	9.0	2.1	3.1	3.3	15.4	8.9	21.8
May, . . .	23.5	10.2	5.8	10.1	9.7	8.6	3.6	4.9	4.3	29.2	16.3	21.1
June, . . .	20.7	8.9	9.6	11.1	10.7	9.9	2.8	5.8	5.1	31.4	18.0	23.9
July, . . .	16.6	7.1	6.6	6.7	6.4	6.8	4.3	6.0	5.7	15.5	8.9	2.6
August, . . .	16.8	7.2	7.5	6.1	5.9	6.6	10.4	14.4	18.5	5.7	3.3	2.6
September, . .	17.8	7.6	6.8	6.6	6.3	7.6	13.6	18.9	20.6	6.9	4.0	1.1
October, . . .	[redacted]	14.4	11.4	10.3	9.9	9.4	19.6	27.2	22.4	11.2	6.4	1.3
November, . .	30.3	13.0	21.6	13.6	13.2	11.2	11.6	16.0	16.9	17.7	10.2	4.6
December, . .	26.5	11.4	16.9	12.9	12.4	7.8	7.2	10.0	9.2	34.6	19.9	6.8
Mean, . .	23.3	10.0	10.0	10.4	10.0	10.0	7.2	10.0	10.0	17.4	10.0	10.0

The figures in the foregoing table are introduced for the purpose, not of comparing the prevalence of one disease with another, but for

the purpose of presenting the reports of each n
basis of comparison, month by month, so that
of each disease is shown for each month. The
advantage of eliminating the apparent errors of
from the unequal length of the months.

The figures may be read as follows: for example
ber of reported cases of diphtheria and croup in Ja
of scarlet-fever, 13.1; of typhoid fever, 4.6; and
columns marked A); and the mean daily number of
the whole year 1896 was, respectively, 23.3, 10.4, 7
ing a standard of 10 as the daily mean of each di
ratios for January were as follows: diphtheria an
fever, 12.6; typhoid fever, 6.4; and measles, 6.4
B). That is to say, for each 10 reported cases o
occurring throughout the year, as a daily mean, th
January, 11.3 in February, etc.

The following table presents the numbers of
reported from each city and town in 1896. T
reporting cities and towns is less than that of th

Where the name of a city or town occurs bot
in Section III. of this summary, the differenc
taken as the deficiency in returns made by t
State Board of Health.

Cases of Infectious Diseases reported to the State Board o
dred and Forty-four Cities and Towns dur

	Diphtheria.	Scarlet-fever.	Typhoid Fever.	Measles.	
Adams, . . .	60	9	1	–	Barnstable, .
Amesbury, . .	34	23	4	9	Barre, . .
Amherst, . . .	–	1	1	80	Bedford, . .
Arlington, . .	1	4	–	–	Belchertown, .
Attleborough, . .	1	15	–	8	Berlin, . .
Auburn, . . .	–	1	–	–	BEVERLY, .
Avon, . . .	1	–	–	1	Bolton, . .
Ayer, . . .	2	–	–	3	BOSTON, . .

Cases of Infectious Diseases, etc. — Continued.

	Diphtheria.	Scarlet-fever.	Typhoid Fever.	Measles.		Diphtheria.	Scarlet-fever.	Typhoid Fever.	Measles.
Braintree,	-	1	-	-	Hull,	-	1	-	7
Bridgewater,	1	28	2	-	Huntington,	1	-	-	-
BROCKTON,	62	42	20	34	Hyde Park,	2	-	-	-
Brookline,	14	28	1	46	Ipswich,	29	-	1	3
CAMBRIDGE,	452	178	266	213	Kingston,	-	19	-	2
Chelmsford,	1	7	-	109	LAWRENCE,	37	46	41	11
CHELSEA,	87	37	4	29	Leicester,	-	-	-	3
Clinton,	3	23	2	104	Leominster,	4	25	2	115
Concord,	8	8	-	3	Leverett,	-	1	-	-
Cottage City,	2	-	1	1	Lexington,	-	-	-	7
Danvers,	11	15	-	10	Lincoln,	1	1	-	-
Dedham,	16	10	4	19	LOWELL,	106	27	137	107
Dudley,	1	-	-	-	LYNN,	379	183	101	225
Duxbury,	-	4	-	18	MALDEN,	94	45	85	49
Easthampton,	-	5	-	-	Manchester,	-	4	-	-
East Bridgewater,	-	4	-	-	Marblehead,	-	-	-	32
EVERETT,	69	9	23	210	MARLBOROUGH,	10	8	3	50
FALL RIVER,	122	185	83	137	Marshfield,	1	5	-	38
Falmouth,	-	-	-	3	Medfield,	-	6	-	20
FITCHBURG,	42	54	31	36	MEDFORD,	50	14	7	135
Foxborough,	-	4	2	2	Merrimac,	1	26	-	-
Franklin,	1	5	-	-	Middleborough,	2	-	-	10
Gill,	-	-	-	46	Middleton,	3	8	-	1
GLOUCESTER,	93	127	42	-	Milford,	18	4	-	3
Grafton,	-	1	-	-	Millbury,	2	12	1	10
Great Barrington,	-	1	-	-	Milton,	16	20	-	59
Groveland,	1	18	1	1	Monson,	1	4	-	12
Hadley,	1	4	-	12	Needham,	9	3	-	1
Hardwick,	-	3	-	-	NEW BEDFORD,	63	73	74	15
Hingham,	26	1	-	4	NEWBURYPORT,	23	7	4	97
Hinsdale,	1	10	-	-	NEWTON,	159	83	61	191
HAVERHILL,	89	44	105	49	NORTH ADAMS,	24	18	2	2
Holliston,	1	-	-	-	NORTHAMPTON,	46	10	17	-
Hopkinton,	1	-	-	-	North Andover,	4	3	2	5
Hudson,	2	44	2	7	Northborough,	3	3	-	-

Cases of Infectious Diseases, etc. — Con

	Diphtheria.	[redacted]-fever.	Typhoid Fever.	Measles.	
Northbridge, . .	1	1	–	–	Swansea, . .
North Brookfield, .	1	–	–	1	Swampscott, .
Norwood, . .	5	16	–	1	TAUNTON, . .
Palmer, . . .	5	8	1	2	Templeton, . .
Peabody, . . .	6	17	1	–	Townsend, . .
Pepperell, . .	11	7	–	3	Truro, . .
Petersham, . .	–	1	–	–	Upton, . .
Plymouth, . .	8	35	–	12	Uxbridge, . .
PITTSFIELD, . .	94	9	1	67	WALTHAM, . .
QUINCY, . . .	103	68	25	18	Ware, . . .
Randolph, . .	2	2	–	–	Wareham, . .
Reading, . . .	2	4	–	2	Warren, . .
Rockport, . .	3	1	–	–	Watertown, . .
Rowley, . . .	5	2	1	2	Webster, . .
Royalston, . .	–	1	–	–	Westborough, . .
SALEM, . . .	238	130	54	–	West Brookfield, .
Sandisfield, . .	–	5	–	–	Westfield, . .
Saugus, . . .	10	6	–	2	Westford, . .
Scituate, . . .	–	4	2	2	Weston, . .
Seekonk, . . .	1	3	–	–	Weymouth, .
Sharon, . . .	3	–	–	–	Whitman, .
Sherborn, . .	2	–	–	6	Williamstown, .
Shirley, . . .	9	2	–	2	Winchendon, .
Somerset, . .	1	–	1	–	Winthrop, . .
SOMERVILLE, . .	303	141	94	21	Westwood, . .
Southborough, .	–	1	–	1	WOBURN, . .
SPRINGFIELD, . .	70	32	50	23	WORCESTER, .
Sterling, . . .	1	–	–	–	Wrentham, . .
Stoughton, . .	1	1	–	2	Totals, .
Stow, . . .	1	–	–	–	

The following list comprises the cities and t
report (under the provisions of the statute) to
Health. It is but just to state that in many of
group IV. and in some of those in group III.
that no cases of infectious disease occurred.

List of Towns from which no Reports were received.

I. Cities.

Chicopee, Holyoke.

II. Towns having a Population of More than 5,000 in Each.

Andover,
Athol,
Blackstone,
Framingham,
Gardner,
Greenfield,
Melrose,
Methuen,
Montague,
Natick,
North Attleborough,
Orange,
Palmer,
Plymouth,
Revere,
Rockland,
Southbridge,
Spencer,
Stoneham,
Wakefield,
West Springfield,
Winchester. — 22.

III. Towns having a Population of Over 1,000 but Less than 5,000 in Each.

Abington,
Acton,
Acushnet,
Agawam,
Ashburnham,
Ashfield,
Ashland,
Bellingham,
Belmont,
Billerica,
Bourne,
Bradford,
Brookfield,
Buckland,
Canton,
Carver,
Charlemont,
Charlton,
Chatham,
Cheshire,
Chester,
Clarksburg,
Cohasset,
Colrain,
Conway,
Dalton,
Dartmouth,
Deerfield,
Dighton,
Douglas,
Dracut,
East Longmeadow,
Easton,
Edgartown,
Essex,
Fairhaven,
Freetown,
Georgetown,
Granville,
Groton,
Hamilton,
Hanover,
Hanson,
Harvard,
Harwich,
Hatfield,
Holbrook,
Holden,
Hopedale,
Hubbardston,
Lancaster,
Lee,
Lenox,
Littleton,
Ludlow,
Lunenburg,
Mansfield,
Mattapoisett,
Maynard,
Medway,
Millis,
Nantucket,
Newbury,
New Marlborough,
Northfield,
Norton,
Norwell,
Orleans,
Oxford,
Pembroke,
Provincetown,
Raynham,
Rehoboth,
Rochester,
Salisbury,
Sandwich,
Scituate,
Sheffield,
Shelburne,
Shirley,
Shrewsbury,
Southampton,
South Hadley,
Stockbridge,
Sturbridge,
Sudbury,
Sutton,
Tewksbury,
Tisbury,
Topsfield,
Upton,
Uxbridge,
Walpole,
Warren,
Wayland,
Wellesley,
West Boylston,
West Bridgewater,
Westminster,
West Newbury,
West Stockbridge.
Westport,
Wilbraham,
Williamsburg,
Wilmington,
Yarmouth. — 106.

List of Towns from which no Reports wer

IV. Towns having Less than 1,000

Alford,	Halifax,
Ashby,	Hampden,
Becket,	Hancock,
Berkley,	Hawley,
Bernardston,	Heath,
Blandford,	Holland,
Boxborough,	Lakeville,
Boxford,	Lanesborough,
Boylston,	Leyden,
Brewster,	Longmeadow,
Brimfield,	Lynnfield,
Burlington,	Marion,
Carlisle,	Mashpee,
Chesterfield,	Mendon,
Chilmark,	Middlefield,
Cummington,	Monroe,
Dana,	Monterey,
Dover,	Montgomery,
Dunstable,	Mount Washington,
Eastham,	Nahant,
Egremont,	New Ashford,
Enfield,	New Braintree,
Erving,	New Salem,
Florida,	Norfolk,
Gay Head,	North Reading,
Goshen,	Oakham,
Gosnold,	Otis,
Granby,	Paxton,
Greenwich,	Pelham,

The Board will forward to the local board the postal cards necessary for reporting, on local board of health.

IV.

Official Returns of Deaths in Cities and Large Towns (Chapter 218, Acts of 1894).

The following summary comprises the results obtained from the tabulation of the returns required by chapter 218 of the Acts of 1894, whereby the board of health of each city and populous town is directed to send to the State Board of Health an annual statement of the deaths in such city or town upon a blank form furnished by the State Board.

The whole number of cities and towns included in this list is 85, of which number all except the town of Montague complied with the statute. The total population of these 85 cities and towns by the census of 1895 was 2,034,658.

In consequence of the failure of Montague to send a return, as required by statute, the figures for that town have been copied from the published report of the town clerk for the year 1896.

The death-rates of these towns in the following summary for the year 1896 are calculated upon an estimated population, such estimate being based upon the rate of growth from 1890 to 1895, as taken from the census returns.

This estimate would add one more town to the list for 1896 (Williamstown), and the returns of this town are included in the summary, although not required by the statute, making the total number of towns included in the summary 86.

The estimated population of these 86 towns in 1896 was 2,093,820, or about 80 per cent. of the total population of the State.

The whole number of deaths registered in these towns in 1896 was 40,400, and the death-rate calculated upon the foregoing estimated population was 19.29 per 1,000 living. This rate was slightly higher than that of 1895.

Sexes. — The number of deaths of males was 20,530, or 50.9 per cent. of the whole number of deaths; and the deaths of females were 19,834, or 49.1 per cent. of those whose sex was known. There were 36 in which the sex was not stated in the returns.

Ages. — The deaths shown by four groups of ages, as recommended by Körösi, were as follows: —

Ages.	Deaths. 1896.	Percentages of All Deaths.		Ages.
		1896.	1895.	
Under 1 year,	10,073	24.97	22.9	20-50,
1-20,	7,169	17.75	17.9	50 and over,

The deaths of infants under one were 10,0'
of the total mortality, and those of children
14,475, or 35.88 per cent. of the total morta
deaths of infants under one year and that of
ages of twenty and fifty years were nearly ide

All of the percentages in this table are estim
of deaths of persons whose ages were specifie
total number of deaths in which the age was n

Months and Quarters. — The number of dea
the year is shown in the following table: —

	Deaths. 1896.	Percentages.		
		1896.	1895.	
First quarter,	9,524	23.56	26.9	Fourth quarter,
Second quarter,	9,692	23.97	22.7	Date unknown,
Third quarter,	12,360	30.60	27.4	Total,

The intensity of the seasonal death-rate is sl
table, the method employed being explained or
III., relating to disease notification.

Seasonal Intensity of the Death-r

	Mean Daily Deaths per Month. 1896.	Mean Rate compared with a Standard of 100.		
		1896.	1895.	
January,	100.29	90.84	96.2	August,
February,	106.07	96.09	120.8	September,
March,	107.71	97.56	111.7	October,
April,	114.27	103.51	101.8	November,
May,	106.25	96.22	89.9	December,
June,	98.70	89.40	80.9	Annual mean,
July,	147.10	133.24	98.2	

Causes of Death. — The list of causes of death embraced in the summary includes those from the principal infectious diseases, including consumption, together with certain other groups of destructive diseases and those from violence.

The ratio of deaths to the living population is also presented, since this method of presentation constitutes a better method of indicating the incidence of each cause of death upon the living population than the ratio of the deaths from each disease or cause of death to the total mortality.

TABLE I.

REPORTING CITIES AND TOWNS.	Estimated Population, 1896.	REPORTING CITIES AND TOWNS.	Estimated Population, 1896.
Adams,	7,561	Millbury,	5,380
Amesbury,	10,023	Milton,	5,766
Andover,	6,145	Montague,*	6,010
Arlington,	6,692	Natick,	8,753
Athol,	7,573	NEW BEDFORD,	58,724
Attleborough,	8,430	NEWBURYPORT,	14,673
BEVERLY,	12,003	NEWTON,	28,281
Blackstone,	6,019	NORTH ADAMS,	19,747
BOSTON,	507,219	NORTHAMPTON,	17,097
Braintree,	5,403	North Attleborough,	6,545
BROCKTON,	34,483	Northbridge,	5,422
Brookline,	16,976	Orange,	5,519
CAMBRIDGE,	84,188	Palmer,	6,925
CHELSEA,	31,962	Peabody,	10,576
CHICOPEE,	16,894	PITTSFIELD,	21,164
Clinton,	11,711	Plymouth,	8,085
Concord,	5,324	QUINCY,	21,617
Danvers,	8,326	Revere,	7,774
Dedham,	7,228	Rockland,	5,585
EVERETT,	20,599	Rockport,	5,529
FALL RIVER,	92,500	SALEM,	35,258
FITCHBURG,	27,382	SOMERVILLE,	55,018
Framingham,	9,566	Southbridge,	8,369
Franklin,	5,197	Spencer,	7,388
Gardner,	9,833	SPRINGFIELD,	53,131
GLOUCESTER,	28,982	Stoneham,	6,309
Grafton,	5,120	Stoughton,	5,356
Greenfield,	6,424	TAUNTON,	27,461
HAVERHILL,	30,802	Wakefield,	8,568
HOLYOKE,	41,331	WALTHAM,	21,339
Hudson,	5,435	Ware,	7,715
Hyde Park,	12,152	Watertown,	7,931
LAWRENCE,	53,811	Webster,	7,952
Leominster,	9,599	Westborough,	5,243
LOWELL,	85,768	Westfield,	10,884
LYNN,	63,771	West Springfield,	6,334
MALDEN,	31,261	Weymouth,	11,376
Marblehead,	7,564	Whitman,	6,004
MARLBOROUGH,	15,211	Williamstown,	5,020
MEDFORD,	15,153	Winchester,	6,407
Melrose,	12,654	WOBURN,	14,813
Methuen,	5,865	WORCESTER,	101,860
Middleborough,	6,813		
Milford,	8,994	Total,	2,093,820

* Montague, no returns; data compiled from town report.

TABLE II.

Total Deaths, Deaths by Sexes and Age Periods, and Still-births in Cities and Towns having over 5,000 Inhabitants in Each, with General Death-rates estimated for 1896.

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Adams, ...	171	84	86	1	5	46	8	4	9	3	7	6	9	18	9	8	8	11	18	7	-	22.02
Amesbury, ...	176	82	94	-	15	36	7	2	1	2	4	4	9	9	17	18	10	17	18	17	3	17.56
Andover, ...	104	47	57	-	2	12	3	-	-	-	2	1	3	6	6	8	10	17	19	13	-	16.03
Arlington, ...	119	53	66	-	4	32	4	3	1	-	-	1	4	11	7	6	11	16	18	10	-	17.78
Athol, ...	81	38	43	-	4	9	3	2	-	-	1	2	3	11	8	4	13	8	12	10	-	10.70
Attleborough, ...	134	68	66	-	8	33	4	-	3	3	3	1	2	10	17	7	10	16	11	5	-	15.90
BEVERLY, ...	222	108	114	-	12	22	7	2	3	1	32	4	6	14	14	17	17	28	33	23	-	16.60
Blackstone, ...	117	63	54	-	6	30	7	2	1	-	7	1	4	11	9	2	8	17	17	5	-	19.44
BOSTON, ...	11,634	6,073	5,561	-	648	2,670	675	348	216	182	307	137	287	1,178	1,236	1,097	1,083	1,082	822	450	-	22.94
Braintree, ...	101	62	37	2	6	19	8	1	3	1	2	1	1	6	1	10	12	17	16	4	-	15.60
[illegible]	606	293	313	-	20	126	40	25	10	12	27	12	16	55	61	35	56	28	45	36	-	17.64

EVERETT,	317	156	161	-	34	100	20	10	2	2	5	3	8	30	23	24	26	23	27	14	-	15.39
FALL RIVER,	2,202	1,074	1,128	-	235	806	*-	*-	*-	*-	87	†-	†-	155	154	129	130	156	78	39	-	23.81
FITCHBURG,	430	218	212	-	44	143	20	16	9	3	16	4	9	34	35	21	32	39	29	20	-	15.70
Framingham,	137	73	61	3	13	23	6	6	2	1	2	3	6	5	8	10	14	16	23	12	-	14.82
Franklin,	77	34	41	2	6	19	3	1	-	-	2	-	2	8	8	4	9	7	12	2	-	14.82
Gardner,	179	120	59	-	9	40	8	5	6	2	8	1	5	15	12	8	17	21	18	13	-	19.18
GLOUCESTER,	381	195	186	-	24	95	‡-	‡-	‡-	‡-	9	§-	§-	24	30	17	26	38	38	25	-	13.15
Grafton,	79	38	41	-	11	22	6	3	-	-	1	-	1	6	3	2	7	8	8	6	6	15.43
Greenfield,	102	54	48	-	5	15	1	1	-	1	3	-	7	17	5	3	12	10	16	11	-	15.88
HAVERHILL,	558	295	263	-	20	142	22	9	12	7	23	4	12	53	43	43	48	54	62	24	-	18.12
HOLYOKE,	761	360	391	10	58	267	62	27	17	5	19	13	9	67	50	49	60	49	41	16	10	18.41
Hudson,	87	30	57	-	-	19	4	1	-	-	1	-	-	7	10	6	5	12	14	8	-	16.00
Hyde Park,	216	118	98	-	13	44	13	3	4	4	11	6	8	22	22	10	14	17	23	14	1	17.77
LAWRENCE,	1,017	472	543	2	83	315	75	30	9	14	14	12	25	75	71	89	101	89	60	40	2	18.90
Leominster,	158	72	86	-	5	37	5	3	2	1	5	3	5	10	7	9	25	14	14	18	-	16.46
LOWELL,	1,901	902	999	-	173	584	145	58	28	29	53	24	64	165	131	129	159	137	117	78	-	22.16
LYNN,	1,130	564	566	-	85	279	50	24	20	12	40	17	23	104	97	85	114	116	89	60	-	17.72
MALDEN,	481	234	247	-	39	107	20	8	7	3	12	5	7	36	46	44	40	58	57	28	3	15.39
Marblehead,	123	64	59	-	6	15	3	1	2	1	5	4	-	14	12	7	10	11	18	20	-	16.26
MARLBOROUGH,	247	116	129	2	6	64	11	5	2	1	9	2	13	12	25	19	28	29	18	9	-	16.24
MEDFORD,	253	108	145	-	11	62	17	5	6	-	10	7	4	15	21	16	14	25	33	18	-	16.70
Melrose,	193	105	88	-	17	38	‖-	‖-	‖-	‖-	5	¶-	¶-	14	21	19	18	25	15	14	-	15.25
Methuen,	103	56	47	-	6	20	5	-	2	1	3	3	3	12	6	7	9	17	10	5	-	17.56
Middleborough,	109	55	54	-	5	10	1	2	1	-	1	1	1	7	11	6	12	10	21	25	-	16.00

* Three hundred and twenty-seven between the ages of one and five years.
‡ Fifty-five between the ages of one and five years.
‖ Thirteen between the ages of one and five years.
† Ninety-one between the ages of ten and twenty years.
§ Twenty-four between the ages of ten and twenty years.
¶ Eleven between the ages of ten and twenty years.

TABLE II. — *Concluded*

	Total Deaths.	Males.	Females.	Sex Unknown.	Still births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Milford, ...	146	71	75	-	-	21		3	2		6	2	2	10	14	10	10	17	18	15	1	16.28
Millbury, ...	96	50	46	-	5	30	2	2			1	2	2	7	8	7	8	10	12	8		17.84
Milton, ...	66	32	34	-	3	16	2	1			3	4	2	4	5	2	2	7	9	5		11.48
Montague, ...	119	54	64	1	6	28	6	1	1	2	5	5	3	7	11	10	11	5	17	8		19.80
Natick, ...	111	59	52	-	9	7		-		1	1		2	10	9	16	16	12	16	5	10	12.68
NEW BEDFORD, ...	1,192	616	576	-	99	466	54	23	23	9	21	14	29	84	70	61	84	65	65	65		20.30
NEWBURYPORT, ...	253	125	128	-	14	48	[illegible]	[illegible]	[illegible]	[illegible]	3		[illegible]	20	16	13	24	38	30	27		17.24
NEWTON, ...	496	243	253	-	22	101	24	14	7		13		20	40	36	22	44	66	63	58		17.84
NORTH ADAMS, ...	363	191	172	-	27	104	25	7	4		6	8	14	25	40	17	33	21	27	9		18.38
NORTHAMPTON, ...	322	168	154	-	15	65	[illegible]	[illegible]		[illegible]	1	[illegible]	[illegible]	56	34	21	30	48	42	28		18.86
North Attleborough, . .	101	50	51	-	5	14	5	-	2		2	2	5	11	10	7	19	12	6	5		16.48
Northbridge, ...	140	70	70	-		20		4	4	4	6	6	1	8	11	7	8	17		8		26.01

Rockport,	74	41	33	-	4	14	8	-	1	-	2	1	2	5	4	3	5	6	15	10	1	13.39
SALEM,	746	368	378	-	45	193	35	15	16	6	29	11	18	54	51	46	60	79	79	61	8	21.16
SOMERVILLE,	924	460	464	-	52	206	66	23	20	21	38	16	19	74	68	68	69	101	80	53	-	16.80
Southbridge,	154	84	70	-	6	36	14	4	1	-	5	4	5	12	16	12	8	11	9	13	1	18.40
Spencer,	87	39	48	-	5	9	3	2	2	1	-	1	2	7	10	6	7	8	18	11	-	11.77
SPRINGFIELD,	954	493	461	-	53	234	39	14	17	12	30	12	23	72	72	77	78	98	104	66	6	17.96
Stoneham,	105	49	56	-	2	21	4	1	2	1	2	1	1	7	7	5	16	14	10	14	-	16.64
Stoughton,	121	72	49	-	4	28	3	2	1	1	4	1	2	12	9	4	7	15	18	14	-	22.69
TAUNTON,	583	291	292	-	30	141	16	6	5	6	16	5	16	44	50	43	54	76	65	34	-	21.25
Wakefield,	158	87	71	-	8	47	6	2	1	-	3	1	3	11	9	6	9	24	24	10	-	15.44
WALTHAM,	345	200	145	-	15	73	18	9	1	5	7	7	6	26	21	24	25	43	49	30	1	16.17
Ware,	139	76	63	-	12	59	6	2	3	1	3	6	4	18	10	7	12	11	11	6	-	18.02
Watertown,	123	60	63	-	9	25	2	2	3	1	4	-	1	11	10	16	15	13	15	6	-	15.51
Webster,	129	77	52	-	3	39	6	-	2	1	1	-	4	11	10	5	12	15	11	11	1	16.22
Westborough,	122	59	63	-	1	9	4	3	3	1	8	-	3	4	12	14	10	19	19	18	-	22.27
Westfield,	163	91	72	-	8	28	3	2	-	1	6	4	7	14	12	6	11	20	23	13	-	15.06
West Springfield,	105	62	43	-	2	23	6	1	1	1	2	5	4	7	10	8	6	8	12	6	-	16.58
Weymouth,	186	89	97	-	6	32	9	1	1	-	1	2	3	13	21	17	16	26	30	14	-	16.35
Whitman,	81	48	31	2	5	17	2	1	-	-	-	1	2	8	1	7	12	10	14	8	-	13.49
Williamstown,	83	45	38	-	2	17	2	8	1	-	3	4	3	7	4	8	3	8	9	6	-	16.58
Winchester,	96	52	44	-	10	15	4	3	[illegible]	-	4	3	6	6	5	8	7	11	11	10	-	14.96
WOBURN,	233	117	116	-	13	80	13	1	5	3	5	3	5	18	18	13	14	25	16	16	-	16.38
WORCESTER,	1,796	916	880	-	115	407	56	40	25	24	42	16	42	171	149	178	180	185	172	99	-	17.03
Total,	40,400	20,530	19,834	36	2,572	10,073	2,006	909	605	435	1,139	521	949	3,536	3,434	3,104	3,533	3,625	3,489	2,173	63	19.29

* Twenty-seven between the ages of one and five years.
‡ Twenty-three between the ages of one and five years.

† Nine between the ages of ten and twenty years.
§ Thirteen between the ages of ten and twenty years.

TABLE VIII.

Deaths by Months in Each City and Town having a Population of More than 5,000 by Census of 1895.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Unknown.
Adams,	16	12	7	15	13	8	20	24	19	14	10	14	-
Amesbury,	14	13	10	12	17	16	26	21	16	12	10	11	1
Andover,	13	9	6	5	7	9	9	15	6	6	9	11	-
Arlington,	10	6	9	3	11	13	14	15	16	11	9	4	-
Athol,	6	5	7	5	6	8	6	10	6	8	7	10	-
Attleborough,	10	14	11	13	16	15	13	11	6	11	8	9	-
BEVERLY,	15	19	13	22	22	17	17	31	27	13	14	12	-
Blackstone,	20	6	10	11	11	9	16	16	9	10	4	7	-
BOSTON,	921	928	1,048	1,019	967	821	1,283	1,134	908	879	816	917	-
Braintree,	3	8	11	7	13	8	7	14	10	4	7	8	-

EVERETT,	22	25	20	21	27	23	44	39	24	21	28	23	-
FALL RIVER,	151	126	135	165	173	225	329	256	189	162	135	156	-
FITCHBURG,	30	29	43	36	38	31	49	45	28	28	33	40	-
Framingham,	6	10	12	17	15	6	12	18	18	5	10	7	1
Franklin,	4	6	6	10	11	4	5	10	7	6	8	5	-
Gardner,	9	10	21	14	13	11	12	26	18	10	16	19	-
GLOUCESTER,	29	23	26	34	40	26	29	51	38	39	27	19	-
Grafton,	8	7	6	9	3	4	4	8	14	6	4	6	-
Greenfield,	5	7	7	9	8	5	11	9	10	14	4	13	-
HAVERHILL,	37	37	32	45	50	38	66	65	49	50	39	50	-
HOLYOKE,	67	55	61	51	45	71	95	85	68	58	44	61	-
Hudson,	6	7	6	7	3	4	1	12	11	9	12	9	-
Hyde Park,	12	11	18	25	22	14	23	35	20	9	11	16	-
LAWRENCE,	75	84	82	110	81	69	117	108	78	72	64	77	-
Leominster,	19	13	12	15	9	10	18	18	5	16	14	9	-
LOWELL,	124	143	170	175	117	131	237	223	157	157	126	141	-
LYNN,	93	97	87	90	90	86	115	128	91	86	72	95	-
MALDEN,	51	33	37	58	48	28	52	38	42	34	32	28	-
Marblehead,	10	10	11	12	8	9	10	20	10	8	9	6	-
MARLBOROUGH,	24	13	20	15	17	23	31	37	12	18	15	22	-
MEDFORD,	23	18	15	19	21	26	36	32	22	14	22	10	-
Melrose,	20	12	14	20	13	12	23	28	13	11	14	13	-
Methuen,	7	9	11	6	11	11	7	11	7	12	4	7	-
Middleborough,	12	9	8	10	8	6	12	18	5	8	9	4	-
Milford,	12	10	17	11	12	11	21	10	7	9	11	15	-

TABLE III. — *Concluded.*

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Unknown.
Millbury,	9	10	17	12	5	8	8	8	9	4	4	2	-
Milton,	7	6	5	6	9	5	4	8	8	4	5	4	-
Montague,	8	7	10	15	9	11	17	12	10	6	7	9	-
Natick,	8	6	8	9	10	7	13	13	10	11	12	8	-
NEW BEDFORD,	71	111	57	60	126	70	130	178	93	85	63	76	-
NEWBURYPORT,	16	24	26	26	25	15	36	21	17	21	19	24	-
NEWTON,	45	38	30	41	45	42	47	56	33	31	37	36	-
NORTH ADAMS,	22	26	37	36	32	34	56	40	21	23	26	29	-
NORTHAMPTON,	17	22	16	25	19	26	38	30	21	30	30	36	-
North Attleborough,	10	6	9	5	7	9	10	8	13	5	6	10	-
Northbridge,	7	8	15	10	9	12	16	21	13	12	16	8	-
Orange,	8	6	7	4	12	4	7	7	5	6	7	9	-
Palmer,	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SOMERVILLE,	80	68	70	71	73	64	101	89	95	74	65	74	-
Southbridge,	12	13	12	15	8	12	11	10	20	20	12	9	-
Spencer,	10	8	5	2	6	10	6	8	5	14	4	9	-
SPRINGFIELD,	70	62	78	86	71	76	111	100	88	68	66	78	-
Stoneham,	10	7	7	7	12	9	16	7	8	4	11	7	-
Stoughton,	9	16	11	7	10	7	8	25	8	7	4	9	-
TAUNTON,	49	47	49	50	56	40	74	62	40	48	30	33	-
Wakefield,	10	8	11	14	12	9	19	22	14	11	9	19	-
WALTHAM,	30	. 28	29	38	27	31	17	34	41	24	23	23	-
Ware,	12	9	14	7	11	14	10	19	7	12	11	13	-
Watertown,	7	12	8	8	13	7	18	14	9	9	9	9	-
Webster,	9	11	12	15	7	4	7	16	17	11	10	10	-
Westborough,	10	10	13	5	6	5	11	24	10	11	7	10	-
Westfield,	20	14	9	11	14	11	20	21	9	10	5	19	-
West Springfield,	5	7	15	7	9	7	18	8	10	4	5	10	-
Weymouth,	21	15	15	19	18	12	16	21	12	9	12	16	-
Whitman,	3	2	8	4	7	7	9	11	12	8	5	5	-
Williamstown,	8	6	4	6	14	6	14	3	10	6	2	4	-
Winchester,	5	15	8	8	11	5	9	15	8	3	7	2	-
WOBURN,	15	17	22	21	17	15	22	22	26	18	19	24	-
WORCESTER,	186	142	163	160	149	143	174	178	141	183	119	158	-
Total,	3,100	3,076	3,330	3,428	3,293	2,961	4,560	4,462	3,338	3,013	2,722	3,094	5

TABLE IV.

Deaths from Specified Causes in Cities and Towns having More than 5,000 Inhabitants in Each.

	Consumption.	Measles.	Scarlet-fever.	Diphtheria and Croup.	Whooping-cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Adams,	29	1	-	12	-	5	5	1	3	2	-	15	-	3	9	4	23	11	11	4	1	4	8	20
Amesbury,	25	1	-	2	-	-	2	1	2	-	-	13	4	1	11	3	23	17	10	10	1	6	2	42
Andover,	11	-	-	-	-	1	1	-	-	-	1	-	-	-	5	4	18	10	1	-	1	3	-	48
Arlington,	15	1	-	-	-	1	4	-	-	-	-	9	-	1	8	-	18	14	7	4	-	1	-	36
Athol,	9	-	1	-	-	-	-	-	-	-	-	3	1	-	10	1	9	1	3	5	1	4	2	31
Attleborough,	14	-	-	4	2	-	1	-	3	-	-	6	2	1	20	4	14	11	7	6	2	8	10	15
BEVERLY,	14	-	1	8	-	4	2	-	-	1	-	8	2	-	18	6	8	11	6	5	1	-	-	127
Blackstone,	16	2	-	4	1	1	9	-	-	-	-	12	-	1	8	-	18	1	11	3	-	3	27	-
BOSTON,	1,328	27	121	572	67	162	21	30	20	15	6	575	44	94	1,387	375	861	565	407	389	90	458	72	3,934
Braintree,	12	-	-	5	-	-	1	1	-	1	1	6	2	1	8	3	9	18	4	5	-	-	-	24
BROCKTON,	73	1	1	15	2	6	12	2	2	1	3	43	37	2	36	9	28	53	26	10	5	2	-	186
Brookline,	28	2	2	7	3	-	1	-	-	-	1	13	-	1	17	14	20	8	10	16	1	6	2	71
CAMBRIDGE,	194	5	6	62	13	30	4	5	1	7	-	91	23	84	160	50	97	217	56	54	6	35	164	199
CHELSEA,	82	-	2	22	-	5	1	3	1	-	1	24	3	5	70	25	68	6	16	22	2	13	-	267
CHICOPEE,	28	-	4	25	5	6	2	1	-	2	2	23	1	6	31	13	16	50	9	8	2	13	8	181
Clinton,	24	-	2	4	-	-	-	-	-	-	-	12	3	8	6	8	13	18	8	9	-	8	-	56
Concord,	8	-	-	-	-	1	1	-	-	-	-	2	1	-	4	-	12	2	1	-	-	5	-	25
Danvers,	23	-	-	3	-	-	3	2	2	1	-	3	1	3	16	2	16	1	8	5	1	2	-	23
Dedham,	9	-	-	3	-	2	-	1	-	-	-	4	-	-	9	3	19	-	-	3	3	2	1	60
EVERETT,	40	4	-	7	4	6	18	3	-	1	2	27	-	-	16	19	36	3	13	13	4	6	-	95
FALL RIVER,	168	12	20	40	7	25	4	5	2	6	1	293	8	23	155	85	85	303	85	50	3	50	12	758
FITCHBURG,	59	-	2	19	2	4	-	3	4	-	2	36	-	4	26	19	31	29	18	10	1	16	-	150
Framingham,	9	-	-	4	-	-	4	1	-	1	2	8	-	3	12	3	18	2	8	1	-	2	-	64

Franklin,	5	-	-	4	1	-	1	1	1	-	1	3	-	1	8	2	4	11	5	3	-	4	-	33
Gardner,	14	1	-	7	1	5	9	1	-	2	-	10	1	4	12	6	15	10	11	7	1	1	9	58
GLOUCESTER,	36	2	5	14	8	9	13	1	1	1	-	26	-	4	20	9	36	8	11	16	4	13	-	149
Grafton,	5	1	-	5	1	1	1	-	-	-	1	6	-	2	10	1	8	1	1	3	-	2	-	30
Greenfield,	9	-	-	-	-	1	2	-	-	2	-	2	-	-	1	3	10	1	1	1	1	9	-	50
HAVERHILL,	50	-	4	18	-	18	-	-	6	-	-	33	-	6	49	25	54	62	15	26	3	18	5	167
HOLYOKE,	29	2	-	23	6	4	1	1	4	1	1	56	2	14	49	34	19	5	3	18	2	25	21	441
Hudson,	6	-	-	3	1	5	2	-	1	1	-	6	2	-	6	-	11	9	1	8	-	-	-	36
Hyde Park,	16	-	1	10	1	5	6	-	1	-	-	4	1	3	19	6	3	5	7	3	3	7	-	116
LAWRENCE,	76	1	3	18	11	10	2	1	-	1	-	102	5	16	104	27	62	54	13	26	5	18	12	451
Leominster,	16	-	1	6	-	2	-	-	-	1	-	9	1	-	9	1	17	4	4	7	-	6	2	72
LOWELL,	207	5	1	47	17	35	4	8	2	11	1	220	12	34	165	78	153	49	64	45	4	54	-	698
LYNN,	115	6	4	69	7	27	2	1	-	3	1	75	11	15	92	24	58	16	23	30	6	6	-	517
MALDEN,	73	1	4	5	3	6	17	-	1	-	-	42	7	-	47	21	53	60	21	21	1	17	20	48
Marblehead,	10	-	-	5	-	2	1	-	1	-	2	5	-	2	16	1	23	14	9	5	2	7	13	-
MARLBOROUGH,	63	1	-	4	-	2	2	-	-	-	-	22	3	-	24	1	23	14	14	3	-	-	1	69
MEDFORD,	36	1	-	11	3	3	-	1	-	2	-	23	-	-	11	9	23	-	2	7	4	10	-	118
Melrose,	13	-	1	2	1	2	1	2	-	-	1	6	2	3	9	1	22	18	-	-	4	3	-	109
Methuen,	10	-	-	1	-	2	7	-	-	-	-	6	-	4	9	1	15	5	1	-	2	6	2	51
Middleborough,	10	-	-	2	-	1	-	-	-	-	-	1	4	2	6	5	10	5	2	2	-	2	1	44
Milford,	22	-	1	6	-	1	1	2	-	-	-	15	2	-	11	1	19	14	10	3	-	7	-	81
Millbury,	8	-	1	1	-	-	3	-	-	-	-	8	-	1	14	5	12	12	3	1	-	-	-	37
Milton,	9	-	-	3	-	3	3	-	-	-	2	3	2	2	4	1	3	-	2	1	1	-	-	27
Montague,	13	-	1	2	-	1	-	-	2	1	-	16	-	-	6	4	16	11	3	2	1	11	6	23
Natick,	11	-	-	1	-	2	-	-	-	-	-	7	-	-	9	1	11	1	3	5	-	8	-	52
NEW BEDFORD,	109	1	3	33	10	14	2	-	-	-	-	130	3	14	76	42	90	6	43	30	2	2	14	548
NEWBURYPORT,	16	1	-	9	-	6	1	-	-	4	-	6	-	7	12	8	21	10	5	16	1	5	-	125
NEWTON,	44	-	-	22	1	7	2	2	1	1	3	24	4	1	43	6	30	40	17	14	1	20	4	191
NORTH ADAMS,	26	5	-	3	-	11	20	2	-	4	-	33	5	7	40	22	25	4	12	13	1	7	2	115
NORTHAMPTON,	30	-	-	5	-	1	-	1	-	2	2	15	2	3	27	11	33	43	5	5	2	9	-	116
North Attleborough,	15	-	-	6	-	2	-	-	1	4	-	4	-	-	5	1	13	14	1	7	3	2	-	25
Northbridge,	13	-	-	13	-	1	3	-	-	-	-	12	1	2	18	5	12	16	6	1	-	6	-	26

TABLE IV. — *Concluded.*

	Consumption.	Measles.	Scarlet-fever.	Diphtheria and Croup.	Whooping-cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum	Dysentery.	Diarrhoea and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Orange, ...	10	-	-	-	-	1	1	-	-	-	1	3	-	2	7	1	8	11	5	5	-	6	-	21
Palmer, ...	19	-	-	10	-	2	5	-	-	-	-	14	1	2	4	2	7	13	10	2	-	7	4	15
Peabody, ...	15	-	1	5	2	1	-	-	-	-	-	11	1	1	26	8	18	12	4	9	-	-	-	95
PITTSFIELD, . . .	31	1	-	14	-	10	-	-	1	1	1	21	1	2	33	25	32	28	7	10	1	22	-	104
Plymouth, . . .	11	-	2	2	-	3	2	-	-	1	-	2	-	1	4	1	24	3	5	6	1	2	1	91
QUINCY, ...	41	-	3	15	2	9	16	2	-	2	1	20	1	29	21	6	26	37	13	9	1	10	1	75
Revere, ...	15	1	-	4	-	4	1	-	-	-	-	9	1	-	17	3	13	14	3	6	3	8	6	36
Rockland, . . .	14	-	-	-	-	1	4	-	-	-	1	5	1	1	1	-	8	9	5	4	-	5	16	-
Rockport, . . .	9	-	1	1	-	-	-	-	-	-	-	2	-	1	3	1	11	5	1	4	1	3	4	27
SALEM, ...	52	3	3	30	5	4	-	3	-	3	1	57	8	27	60	25	68	10	41	23	4	11	-	302
SOMERVILLE, . . .	70	6	5	65	5	26	32	6	-	3	-	70	5	3	97	18	84	7	31	24	3	25	-	338
Southbridge, . . .	21	-	-	2	-	-	-	1	1	-	-	5	-	6	18	10	10	17	5	8	-	3	40	12
Spencer, ...	13	1	-	1	-	4	-	-	2	1	1	3	-	2	3	-	4	-	-	7	-	-	-	40
SPRINGFIELD, . . .	89	6	3	26	2	11	3	3	1	6	4	96	1	19	84	30	58	15	66	38	9	44	8	330
Stoneham, . . .	17	-	-	3	-	1	4	-	-	-	-	7	2	1	7	4	12	12	3	5	1	1	25	-
Stoughton, . . .	11	-	-	-	-	3	6	-	1	2	1	8	11	-	5	2	14	11	5	2	1	6	-	32
TAUNTON, . . .	69	-	-	10	2	6	1	1	1	2	2	51	4	-	46	15	39	7	11	19	2	3	-	290
Wakefield, . . .	10	-	-	1	-	3	12	-	-	-	-	10	1	-	13	11	17	28	11	5	-	1	-	35
WALTHAM, . . .	51	-	4	8	4	4	-	2	1	-	2	10	2	16	31	7	33	51	16	15	2	10	1	75
Ware, ...	19	-	-	11	-	-	7	-	1	1	-	12	1	2	8	2	8	1	8	4	-	8	-	51
Watertown, . . .	14	-	-	8	-	4	2	1	-	1	-	4	4	8	7	4	20	10	10	5	-	3	18	5
Webster, ...	9	-	-	6	1	3	2	-	1	2	-	22	1	-	7	3	11	15	4	7	-	2	13	20
Westborough,* . .	11	-	-	6	-	1	5	-	-	-	-	4	1	-	5	4	9	52	6	6	-	-	-	12
Westfield, ...	16	-	-	6	-	3	3	-	-	1	-	13	1	2	13	2	16	5	10	9	1	9	54	-

West Springfield,	9	-	-	2	-	1	1	-	-	1	-	5	1	2	13	-	10	6	4	1	1	9	2	33
Weymouth,	25	-	-	4	1	6	1	-	-	-	-	7	2	4	12	7	30	28	10	5	1	4	18	21
Whitman,	5	-	-	-	-	1	3	-	-	-	-	1	1	-	2	3	8	9	4	4	-	-	1	39
Williamstown,	9	-	-	4	1	1	3	-	-	-	-	6	-	2	17	3	12	6	3	-	-	4	1	13
Winchester,	11	-	-	8	-	-	1	1	-	1	1	4	-	1	9	6	4	7	1	2	-	6	-	34
WOBURN,	24	1	2	5	-	-	-	1	1	1	4	17	2	-	9	8	20	1	5	6	3	2	14	108
WORCESTER,	264	7	6	70	3	14	-	5	4	-	1	112	6	8	165	41	166	278	95	63	8	49	2	430
Total,	4,313	110	222	1,507	211	579	322	109	77	108	58	2,768	309	517	3,718	1,966	3,215	2,698	1,489	1,283	222	1,189	580	13,672

* Including 41 deaths at Westborough Insane Hospital.

	Homicide.
Attleborough,	2
Boston,	14
Chicopee,	1
Clinton,	1
Fall River,	2
Lawrence,	1
Lowell,	1
Marlborough,	1
Northampton,	1
Salem,	2
Somerville,	1
Springfield,	2
Taunton,	2
Worcester,	1
Total,	32

TABLE V.

CAUSES OF DEATH.	Deaths.	DEATHS PER 10,000 OF THE POPULATION.		CAUSES OF DEATH.	Deaths.	DEATHS PER 10,000 OF THE POPULATION.	
		1896.	1895.			1896.	1895.
Consumption, . .	4,313	20.60	21.20	Dysentery, . .	309	1.48	0.80
Measles, . . .	110	0.53	0.40	Diarrhœa and cholera morbus.	517	2.47	2.08
Scarlet-fever, . .	222	1.06	2.10	Pneumonia, . .	3,718	17.76	17.50
Diphtheria and croup,	1,507	7.20	7.80	Bronchitis, . .	1,265	6.04	6.15
Whooping-cough, .	211	1.01	1.04	Diseases of the heart,	3,213	15.35	15.40
Typhoid fever, .	579	2.77	2.60	Diseases of the brain and spinal cord.	2,598	12.41	13.30
Cerebro-spinal meningitis.	322	1.54	1.80	Diseases of the kidneys.	1,439	6.87	6.96
Erysipelas, . .	109	0.52	0.55	Cancer, . . .	1,282	6.13	4.47
Puerperal fever, .	77	0.37	0.41	Suicide, . . .	222	1.06	1.06
Influenza, . . .	108	0.52	1.70	Accident, . . .	1,189	5.68	5.80
Malarial fever, . .	58	0.28	0.26	Unknown or ill-defined causes.	660	3.15	2.33
Cholera infantum, .	2,768	13.22	10.70				

The population upon which the foregoing death-rates are calculated is estimated for 1896 by the usual rule, from the rate of increase in the foregoing five-year period (1890–95).

HEALTH OF TOWNS.

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HEALTH OF TOWNS.

Adams.

Diphtheria seemed to show itself in an epidemic form through the months of September, October and November, and was reported from various localities in the town, while every effort on the part of the board was made to prevent the spread of the disease. Antitoxin as a treatment was used in many cases with very favorable results. Scarlet-fever was a very rare disease for the year, there being only two cases reported. The mortality was marked by consumption, cholera infantum, pneumonia and diphtheria, and exceeds that of last year, other diseases included, by forty deaths.

Amesbury.

The number of complaints of nuisance has not been large, and we believe each one was promptly attended to.

We have been exceedingly fortunate in having only two deaths from contagious diseases this year, as compared with fourteen in 1895.

The past year we have kept a supply of antitoxin on hand, and it has been furnished the physicians as they needed to use it. The experience of most of our physicians is that antitoxin is by far the most valuable agent we have at present for the cure of diphtheria. Sometimes one injection is sufficient; at other times two or even three are used at intervals of twelve to twenty-four hours, using from seven to ten cubic centimeters for a dose. The membrane seems to soften and grow thin, the fever and pulse rapidly assume the normal condition and convalescence is rapidly established.

Arlington.

This year, like the last one, has been free from cause for alarm from any epidemic of dangerous or contagious diseases.

Among occurrences of the year now closing, in a sanitary point of view, of greatest importance is the rapid progress which has been made in the construction of our public sewers and connection of same with the metropolitan system, which now serves a large portion of our town.

Spy Pond has always been notable in the history of our town, and of great interest to our citizens for purposes of recreation and the commercial value of its product of ice. Of late years the problem of how to purify its waters has engaged the attention of citizens and local organizations.

Athol.

There has been a disposition among some property-holders not to comply with the laws, but on the whole there has been a general spirit of co-operation manifested by the citizens in the work of the board. Understanding the effects of the hard times the board has modified its requirements regarding certain by-laws, and endeavored to be as lenient with the property-holders as the health and safety of the public would allow.

Although a system of sewerage extends through most of the streets of the town, there seems to be a disposition among some of the property-holders not to utilize it and connect their premises with the sewers. The number of sewer connections ordered has been fifty.

There have been issued one hundred and twelve permits for plumbing.

Attleborough.

It is interesting to note that the antitoxic serum for the treatment of diphtheria was first used during the year, and that in the two fatal cases it was not employed, the physicians in each case being called too late.

Next to pneumonia, the disease causing the largest number of deaths is consumption.

Belmont.

During the year there has been no serious epidemic of contagious disease. A mild epidemic of measles in the spring necessitated the closing of one of the schools, but no deaths have occurred in the past year from any contagious disease.

Boston.

The total number of deaths for the year was 11,634, an increase over the previous year of 305 deaths. The death-rate for the year was 22.53 per 1,000 inhabitants. This rate is less by .07 than that of the previous year, and the lowest since 1884. There were 1,985 deaths from zymotic diseases, an increase of 17 deaths over the same group of the previous year. There were 72 less deaths from diphtheria than in 1895, although the number of cases of diphtheria reported was largely increased on account of the larger number discovered among the pupils in the public schools by the medical inspectors of schools, and the bacteriological tests in the otherwise unrecognized cases. The ratio of deaths to the number of cases of diphtheria reported was 11.49 per cent., as against 14.48 per cent. the preceding year. There were 121 deaths from scarlatina, 7 more deaths than in the preceding year, and 72 less than the average of the five previous years. Typhoid fever caused 162 deaths during the year. There were 19 deaths from measles during the year. The number of deaths of children under five years of age was 4,055, compared with 3,935 for the previous year, showing an increase of 120 deaths.

The medical inspection of schools has been continued during the past year, with the same encouraging and satisfactory results as during the previous fourteen months. All pupils who have complained or appeared to their teachers to be ill have been examined by the visiting physicians, and the teachers advised as to what should be done with such pupils. The teachers and visiting physicians have entered upon and pursued this work with surprising harmony. The search for infectious diseases in the schools during the last year has been even greater, while the number of cases in this class found in 1896 is less than that of 1895. The same is true also of the other miscellaneous diseases. Considerable inquiry has been made by officials of other cities as to our methods and results in this work, and several cities, including New York, are now preparing to adopt a similar system of inspection in their schools.

For the year ending Dec. 31, 1896, the whole number of pupils examined was 8,964, and of this number 1,156 were found to be too ill to remain in school. The diseases found may be classified as follows: —

Specific infectious diseases,	267
Oral and respiratory diseases,	3,934
Ear diseases,	66
Eye diseases,	382
Skin diseases,	628
Miscellaneous diseases,	3,687
Total number of examinations,	8,964

Much work is reported by the board as having been accomplished during the year in the line of school-house sanitation, improvement of the condition of exposed tide-water flats near the city, and house-to-house inspection.

Number of houses ordered to be vacated, 121. Many of them were afterward put in good condition and were allowed to be occupied.

Disinfection in infectious diseases, total number,	5,229
Rooms disinfected,	9,967
Sulphur used (pounds),	44,348
Nuisances abated by disinfection,	41,686

The steam disinfecting apparatus at Swett Street has been in constant use throughout the year.

The board proposes to supersede the old method of room disinfection by sulphur, and to employ formaldehyde gas in its place.

The board renews its recommendation for the provision of improved means for disposing of garbage and offal.

The total number of baths taken at the different public sea-water bath-houses in 1896 was as follows: —

Men and boys,	611,894
Women and girls,	189,341
Total,	801,235

The board reports fully upon the following topics: licensing of plumbers and undertakers, issue of burial permits, approval of lodging-houses, paving of courts and alleys, removal of night-soil, assignment of offensive trade locations, inspection of lying-in hospitals, and bakeries.

Brookfield.

The general health of the community has been excellent, and no death has occurred from scarlet-fever, diphtheria or typhoid fever, and, in fact, these diseases have not appeared in town, except three isolated cases of typhoid fever, with one exception probably contracted outside of the town.

Brookline.

Thorough disinfection after scarlet-fever and diphtheria has been done by the board after the recovery or death of the patient, but it has not returned to the use of sulphur fumes for disinfection, except when specially requested, when it is used in conjunction with more reliable means.

Intermittent fever (malaria) has continued to be somewhat prevalent in Brookline, as well as in all the adjoining municipalities. Under the provisions of chapter 80 of the Public Statutes the board of last year ordered the abatement of a nuisance consisting of wet and boggy lands lying between Woodland Road and Heath Street. This order has been complied with, under supervision of the town engineer.

The board of health hospital buildings for diphtheria and scarlet-fever have been in use much of the time, and by providing a suitable place for the isolation and care of the first cases occurring in tenements and other crowded dwellings, have doubtless done much to prevent these dangerous but more or less preventable diseases from becoming epidemic, and at the same time have enabled many children to continue in school who otherwise, though well, must have remained out for many weeks.

The number of cases of typhoid fever was larger than usual, but all were of a rather mild type, and some of them were imported from Florida and elsewhere.

The ice supplied the citizens was inspected from time to time, and specimens subjected to bacteriological examination were found free from disease germs.

The need of improved public bathing facilities, recommended in previous reports of this board as an important health measure, has been recognized by the town, and the little swimming tank in the Village Brook has been succeeded by a new public bath, located in the centre of population, and in every respect worthy of the town.

CAMBRIDGE.

Number of inspections made,	3,941
Number of subsequent inspections,	4,329
Total,	8,270

The need of hospital accommodation for cases of infectious diseases dangerous to the public health is still as pressing as ever, and the attainment of this accommodation is apparently as remote. Cambridge has yet to learn that money can be expended in no better way than in providing means for the isolation of cases of diseases that imperil the public health by their infectious nature.

We have in our previous reports shown the necessity for the work of a bacteriologist, and this portion of our work is now, we hope, established on a somewhat permanent basis.

Medical Inspection of Schools. — The city was divided into six school districts, the number of schools in a district varying from five to seven, depending on the distance to be covered by the inspector in his daily round and upon the number of scholars in the schools visited.

The following instructions, a copy of which was sent to each inspector, indicate the lines upon which the inspections are conducted: —

1. The physician is to examine only such children as are indicated to him by the teacher as having complained, or as appearing to be suffering from disease.
2. The physician is to recommend to the principal to send home immediately any child whom he may suspect of having any infectious disease.
3. The physician must not recommend the employment of any special physician or mode of treatment for the particular case.
4. In case of near-sightedness or other trouble with the eyes, or deafness or other ear trouble, to which attention has been directed by the teacher, the physician is instructed to suggest that the principal recommend to the parents that the eyes or ears of the pupil be examined.

The report of the inspector of ice for 1896 indicates that in several instances the danger from past or present pollution of the supply is so great as to render it necessary to prohibit the sale in this city for domestic use of ice which is derived from such impure sources. The following are strong instances of such impure sources of supply: —

"*Horn Pond, Woburn, Mass.*

"The northern shore of this pond is thickly settled. A small brook flows into the upper end, which brook also flows through a part of the town and receives the drainage from a number of barn-yards. The danger of contamination of the water from the large population settled on the water-shed is so great as to make it an unsafe one to use for an ice supply.

"A considerable excess of chlorine above that which i indicates a past or present pollution of the water. T region is, according to the State Board of Health, 0.3 report of the inspector shows that the chlorine in t 1.40 per 100,000, and his personal inspection is, we t excess cannot be attributed to a source of pollution that

"*Lake Quanapowit, Wakefield, M*

"The town of Wakefield borders on one end and side, other side. The water-shed of this pond supports far make the pond a suitable one from which to cut ice for 1.35 per 100,000. Normal chlorine of this region, 0.38

"*Spy Pond, Arlington, Mass.*

"The northern shore is high and entirely taken up wi drains, apparently for surface water only, were seen e this shore The other banks are, with the exception c shore, taken up with market gardens and with nume water. The danger of contamination is considerable, from the market gardens, on which large quantities of it, I am informed, consisting of night-soil. Chlorine, 2 chlorine of this region, 0.40."

"*Smith's or Little Pond, Belmont,*

"Two brooks flow into it; one draining Spy Pond, land between Belmont and Arlington, which is largel dens. The pond empties through Little River into Alev of *bacillus coli communis* developed during the examin is strong evidence of sewage contamination. Chlorine mal chlorine of this region, 0.40."

"*Sandy Point, Ayer, Mass.*

"There are a few houses at the lower end, and on c but little used picnic ground with a privy about ten or t Chlorine, 0.40 per 100,000. Normal chlorine of this re

"*Waushakum Lake, South Framingha*

"There are several picnic houses around the shore grove on one side. A small dwelling-house is close t houses. Chlorine, 0.50 per 100,000. Normal chlorine

The above quotations from the report of the i clearly as they do the pollution of many of the sour the amplest confirmation of the position taken by mendation above referred to, as to the necessity t tion of those sources of supply.

In accordance with the provisions of chapter 418 of the Acts of 1896, the various bakeries in this city have been inspected, and a printed copy of the act posted in each bakery and place in which the business mentioned in said act is carried on.

Chicopee.

Since September 1 there has been a marked increase in the number of cases of diphtheria and croup, thirty-five being reported for November and the same number for December. In some instances the quarantine was disregarded, and it is quite evident that some of this sickness might have been prevented had it been properly respected; it is, therefore, imperative that rigid measures should be taken to enforce its observance. Antitoxin treatment in a number of cases has met with very satisfactory results.

No provision has yet been made by the city authorities for the removal of garbage and other refuse, which is a constant menace to the public health. During the winter season it accumulates in frozen masses, while each day fresh and liberal additions are made, particularly in the thicker settled sections, until the spring arrives and the health officer again appears to assume the duties of the coming season. The introduction of some system that would be thorough and effective is the only way to overcome this monstrous form of filth.

Clinton.

With reference to diphtheria the board feel that what was recommended last year voices substantially their position this year in the matter, *i. e.*, that the use of antitoxin is of undoubted merit, and should be begun early in the disease.

Concord.

We have endeavored to procure the passage of a bill in the present Legislature permitting the board to inspect the houses owned by the State and occupied by the officers of the Massachusetts Reformatory in this town. As the result of a hearing we were given leave to withdraw, and the case now stands as before we acted. We have no rights in any of the above houses, either to inspect or to investigate upon the occurrence of any contagious disease, to quarantine or to fumigate.

The matter of more thorough sanitation in barns where cows are kept is receiving considerable attention all over the State, in view of the well-known intimate connection between tuberculosis in cattle and poor ventilation of barns. We feel, therefore, that this matter should be attended to the coming year. Its importance is clearly manifest through a communication from the city of Cambridge inquiring about the general sanitary condition of some fifty farms in this town where milk is produced and sold to dealers in Cambridge. The questions are very searching, as they have traced the two epidemics of typhoid fever occurring last summer and fall to the carelessness of the milk peddler in handling the cans. Naturally they

desire to know more about the sources of their r
decided to have our agent, in his annual tour of it
report more fully with reference to the condition
order that we may determine in what way the condi
and what can be done, either by regulation or inspe
eral conditions better.

DANVERS.

The diphtheria antitoxin of the State Board, whi
our board, has been quite largely used, also the
diagnosis of diphtheria. Diagnosis of cases of c
these tubes is reported from the State Board im
after the culture has been sent from Danvers.

In a former report the board stated that the only
the disposal of sewage was for the town to have
present board is of the same opinion, and would
steps towards having such a system in the near futu

DEDHAM.

The cases of contagious diseases reported during
45 in number, which, by comparison with the re
year of 98 cases, shows a relative improvement i
were 15 cases of diphtheria in 1896, and the de
cases of diphtheria from that recorded for the prec
56 cases in 1895, is of special interest.

EVERETT.

The city is in as good sanitary condition as last y

There has been some impatience on account of
persons have been kept in quarantine in cases of
lence of the germs has been tested in these protr
been found that the bacilli are as virulent as in th
fore it is the only safe rule to keep the patient quar
do not appear. We believe that every case is due
some infected person or article. Of 60 cases in w
all but one were proven to have bacilli, or else
others had diphtheria. Of these there were 5 deat
cent. Of 30 cases where it was not used a culture
in 20 cases. There were 6 deaths, a mortality of 2

FALL RIVER.

All houses in which contagious diseases are re
mediately visited and the occupants furnished w
instructions and reliable information upon the pre

stay the spread of that particular disease. In cases of diphtheria and scarlet-fever, cards, designating the disease, are attached to the building, at every door; and in all cases a thorough inspection of the sanitary condition of the building and premises is made; all reports and complaints received through the police department or from citizens are subject to a thorough investigation; when an owner of property has any reason to suspect that the plumbing or the drainage system of the same is unsafe, an inspection is promptly made; when a new sewer is laid in a street previously unsewered, every building situated upon a line of said sewer is visited and inspected, and if upon such inspections it is found that any conditions exist inconsistent with the rules and regulations of the board, an order is immediately served upon the owner, calling upon him to abate such nuisances, reconstruct plumbing or otherwise conform to the rules and regulations, in accordance with the city ordinances and the Public Statutes.

The board supplies the means whereby physicians can determine exactly whether or not any doubtful case of throat disease is or is not diphtheria, by providing the facilities necessary for an expert bacteriological examination of cultures taken from the throat of suspected patients. For this purpose, boxes containing culture tubes, swabs and full printed instructions for taking cultures, with blank form to make a report upon, are distributed at drug stores throughout the city.

The number of persons successfully vaccinated at this office during the past five years was 8,396.

Fitchburg.

The number of written notices issued requiring the action of the board was 527. This includes the general notices regarding nuisances, construction of cesspools, orders to connect with the sewer, defective plumbing to be remedied, and many others of miscellaneous character.

The board has found the schools to be the most likely source of contagion in many cases, most of the cases being among scholars or families of scholars attending school. In several different instances it has been thought advisable to fumigate and disinfect the school buildings, and this has had a noticeable effect in checking the spread of contagion.

Franklin.

We have attended promptly to such complaints as have been brought before us, and have ordered such action as seemed to be called for in each case. It is a pleasure to report that we have found citizens ready to co-operate cheerfully with this board in maintaining the health of the town, and our business has been transacted without friction or unpleasantness.

Gardner.

Considering the number of cases of diphtheria, a every case, it is remarkable that there were not mor reported. To a certain degree this is owing to tl was administered in seven cases, some of them havi hours to live. Every case where it was used re health took active measures to limit the spread of we feel our efforts were more or less successful.

Gloucester.

We consider the sanitary condition of our city v tion of a few localities. Privy vaults and cessp intolerable nuisance, and are, we believe, directly deal of avoidable sickness. A system of seweraq the existing pernicious state of affairs.

Haverhill.

The method of disposal of refuse, animal, vegeta ing the board the usual trouble, and will probabl an ideal method of disposal is found.

The board renews its annual statement as to a diseases, required by law, still uncomplied with.

The middle of June, in which there are usually n found the city suffering from an epidemic of typhc nately not of a very fatal character. Not since t present water supply has there been in any season city as occurred during the summer and autumn mo dred and one cases have been reported from the mi of the year, 90 or more of which had their direct or

The following extract is from Professor Sedgwic evident that two-thirds of all the cases, excluding i of earlier date, were located upon one of the wate derived from Crystal Lake. I therefore visited the sanitary condition, and I regret to say that the r while they show that the lake has a good natural be easily guarded and kept in good sanitary condit present time proper safeguards do not exist; and it from the more or less public uses of the lake for p contamination may have come which caused the p informed that a part of the shore is used for picni club-house with its sink-spout and its privy stands far from the intake of the water works; boating o common; and other evidences exist of improper us

is no positive evidence of any contamination of the lake by any one having typhoid fever; but it is well-known that 'walking' cases of this disease are not uncommon, and it may be that such a contamination has actually occurred. In any case there can be no doubt that the city of Haverhill should own and control not only the lake but its entire shores. A lake which supplies drinking water to a modern city should not be used for boating, fishing or swimming; nor its shores for cottages or picnic grounds; and until Crystal Lake can be entirely rescued from its present uses by the miscellaneous public, those who drink the water derived from this source would do well to boil and cool it before drinking. I have also visited and inspected Round Lake and its environs, and I am of the opinion that the use of its shores for ice-houses, stables, etc., as at present conducted, is improper, and constitutes a menace to the public health."

Ipswich.

A few words in regard to the sanitary condition of the town; we consider that it is in a good condition, taking everything into consideration. We have had considerable complaint from overflowing cesspools during the year, a matter which we expected, owing to the large usage of water; but we think this will be obviated in the future and that we shall have very little trouble from this source.

Lexington.

The vexed question of piggeries seems to have been settled, and we are gratified to say that no complaint has been made in that direction for a long time. The board, however, is well aware that the swine-keeping industry in this town must be carefully watched, and in this connection we know, from much time, trouble and labor expended by us in the past, that "eternal vigilance" is the price of health; hence we cordially invite co-operation by the citizens toward the regulation of this somewhat unsavory traffic; and co-operation in this manner, — not by complaint in an unofficial form to the casual listener, but by direct complaint *in writing* to this board.

Lowell.

Vaults removed in 1896,	169
Cost of burning garbage at cremator, Jan. 1, 1896, to Dec. 26, 1896,	$3,343 34
Cost of burning garbage, 1894,	5,742 69
Cost of burning garbage, 1895,	3,662 53
Cost of burning garbage, 1896,	3,343 34*
Lowest week's cost per ton, 1894,	1 02
Lowest week's cost per ton, 1895,	81
Lowest week's cost per ton, 1896,	68

* Saving in 1896 of $319.19.

During the year 1896, 33,389 loads of ashes wer
and stores to the various dumping grounds in use.

Sixty-five bakeries were inspected by the board un

The number of physicians who have availed them
logical test has largely increased, and the results ha
faction. There have been one or two cases when the
the result of the bacteriological report, considering
follicular tonsilitis, and where the examination prov
theria. In last year's report it was suggested that
cal examination be made before a case with diphth
quarantine. The most approved custom is that ther
reports before the case be released.

Diphtheria cases where antitoxin was used: Cas
died, 3; per cent. of deaths, 10.

Diphtheria cases where antitoxin was *not* used:
35; died, 44; per cent. of deaths, 56.

The board decided to have sputum examined b
cases of suspected tuberculosis of the lungs, and
were sent to the physicians of the city. It was not
ing the cases, although according to the latest accept
is a contagious disease, but simply as an assistan
making his diagnosis.

The board of health believes, as stated in its
modern filter plant of suitable capacity should be
iliary to the present provision for Lowell's water
is not expensive as compared with other measures
Its use in Lowell has already been advised by the
the State, and its efficiency in preventing typhoid
demonstrated. This board feels impelled to urge t
of the people of Lowell with this final safeguard
has already wrought so much danger here.

Lynn.

By a suggestion from the local board of health,
dered all dogs running at large to be muzzled from
1896.

The board also secured the enactment of a statut
ing of low land up to an established grade in the c
required by the board.

The following rule, known as rule 35 of the revi
board of health of the city of Lynn, was adopted,
solicitor Hon. John R. Baldwin, and after a public h
The purpose of the act was to keep out and prevent

from unhealthy cows. Under this order 3,471 cows have been tested with tuberculin in the three States of Massachusetts, New Hampshire and Maine, and of this number 562 were condemned.

RULE 35. On and after May 1, 1896, for all milk brought into or offered for sale in the city of Lynn, satisfactory evidence will be required of the producer and dealer by the board of health that the milk has been drawn from healthy cows. The condition of health is to be based upon results of tuberculin test by a veterinarian that is satisfactory to the State Cattle Commission and to the inspector of milk for the city of Lynn. After test, each animal to have ear tag and certificate of health. Also, that the animals used are properly fed, and the premises occupied by them are in a good condition of sanitation.

Hospital for Contagious Diseases. — The condition of the hospital for contagious diseases the past year has been very satisfactory. It has been the purpose, in the management of this institution, to treat, as economically as possible, those patients suffering from diphtheria or scarlet-fever, who would have no other care or shelter without it, and to prevent the spread of these troubles, and we believe in the last year the institution, with the liberal use of antitoxin, has been the means of preventing a much larger number of cases and a much larger death-rate. A large proportion of these cases has come from those districts where the sanitary conditions are poor, and among those people whose families are large, and who are not accustomed to cleanly habits. For these reasons we believe that the hospital is a department working good in the city. The large number of cases of this kind reported shows how closely we may have come to an epidemic, such as has occurred in our neighboring towns and cities, where no provision has been made for their isolation. In the light of these events it seems a wise foresight on the part of our city in establishing this institution. Of the 82 cases of diphtheria admitted and treated there were 6 deaths, making a mortality of 7.32 per cent., while the mortality in the whole number reported in the city was 14.55 per cent., — about twice the death-rate of that at the hospital.

It is quite a practice in families where a contagious disease occurs for the parents to send the apparently well members away until the sick patient recovers. This course may seem proper and reasonable to a parent in his anxiety for the health and safety of his children, but it is a doubtful expedient, as it was found upon an inspection of cases reported that the patient was only stopping there temporarily, having been sent away from home to escape the disease. In one instance there were several cases reported from the immediate neighborhood of this temporary resident.

The following extract is from the report of the milk inspector: "For some reason other than a popular demand the practice of adulterating and diluting milk continues. This practice was attributable, during at least nine months of the year, to the annual destructive 'milk war.' Certain

dealers conceived the idea of cheapening the co
and it is safe to say they were successful beyond t
ing a part of this time milk sold as low as three c
The quality of the milk was naturally affected,
thirty-three dealers were brought into court; thirt
charged. During the year I have seized and caus
samples of milk and 103 samples of cream; of thes
the standard required. As one great source of th
unclean cans, and ill-kept rooms where milk is pu
three visits to these places, with the view, if neces
conditions as seemed detrimental to health."

Malden.

The gratifying results which have accompanied
of diphtheria has robbed this disease of a certain
The reduction in price of this human boon, couple
board has freely furnished it upon request in all
the death-rate in our city of this most dreaded of
the board would endeavor to indelibly impress up
the great existing need of a contagious ward or ho

In January the State Cattle Commissioners issu
ing that all dogs within a specified territory be
The boards of health of the several cities and town
were authorized to see that the order was duly enf
territories. The city of Malden being included in
health, to the best of their ability, enforced the or
Jan. 23, 1896.

Regular medical inspection of the schools has
mended, and the results have been very gratifyin
has been adopted. The board would recommend
measures for Malden, and that an appropriation

Marblehead.

There has been no serious epidemic of any of
The number of cases of diphtheria has been abou
but the mortality is not so great. This, in the
due to the fact that in most cases antitoxin was
the State Board of Health, furnished antitoxin f
it.

Marlborough.

The quarantine in cases of diphtheria has been
when the throat cultures showed presence of the
board has adopted the plan of releasing patients

throat culture was found free from the germs of this disease. This rule seems to the board to be a reasonable requirement, but the practical enforcement of such a regulation is often a hardship to the patient and family afflicted. In two cases which were quarantined during the year the germs remained in the throat for about ten weeks. As diphtheria patients are sometimes very much longer than ten weeks in getting rid of all diphtheria germs in the throat, and as the experience of the year is quite likely to be repeated, the necessity of providing an ample place for caring for this disease immediately suggests itself.

As our population increases the need of a systematic method of garbage collection becomes more apparent. The work of collecting swill and garbage is now being done by citizens, who register in the office of the board of health and agree to conform to the rules and regulations of the board in this respect; and although the swill is of some value to them, it is not enough to induce them to collect it in a systematic manner, for they generally go to the places where they can get the most and the best with the least possible trouble; so there are a great many places that are not visited, because, to use the words of the collectors, there is not enough to pay for the trouble. This matter can never be settled satisfactorily until the city makes an appropriation for the purpose of employing some one who shall gather swill and garbage in the city, and shall be under the direction of the board of health.

Medfield.

Your board has acted on all complaints of nuisances existing in our town, and has remedied the same as they have deemed best. We have also taken such means and measures to prevent the spread of contagious diseases as in our judgment was proper. In combating the spread of infectious diseases, we have been obliged, in two instances, to remove the families from their dwellings while their apartments were being disinfected. In one instance we considered it best to remove the patients from their houses, as each recovered, to a temporary convalescent hospital, which we maintained for a period of two weeks for their benefit. We have allowed the town to bear the expense of maintaining this hospital, and also the cost of the board and lodging of the other family while this board kept them out of their home.

Medford.

The work of the board has been materially increased during the past year by placing in its charge the inspector of plumbing, connecting with sewers, and the ordinance passed by the Cattle Commissioners, Jan. 23, 1896, requiring the muzzling of dogs.

At the close of the year a circular was sent to physicians who had reported cases of diphtheria to the board during the year, eliciting the following information: Eighty-two cases were reported. From 55 of these

cases cultures were taken and sent to Tufts or H laboratories, or to the State Board for bacteriologic theria bacillus was present in 45 cases; in 10 no present. Antitoxin was used in 59 cases. Deaths where antitoxin was used. Arrangements have b State Board of Health whereby microscopical exam

MELROSE.

The correctness of the reports of contagious dise by the concealment of cases of sickness with the m and scarlatina. This comes, perhaps, from a relu posted upon the house, and persons sometimes t by not employing any physician. But this is no clearly: "When a house-holder knows that a pe sick with . . . any contagious disease . . . he notice to the board of health. . . . Any person . . . shall be punished by a fine not exceeding one

The board has endeavored to have the sewer possible by the people, and therefore has followed sewer by a house-to-house distribution of circulars of speedy connection with the sewer, and urging e

MIDDLEBOROUGH.

There has been no serious outbreak of disease year. In January, a case of diphtheria was report upon investigation, we were satisfied was contracte

The board firmly believes that the time has c vested in local boards by the statute of 1891 sh village, and the owners on the line of the sewer be not a privy, vault or cesspool can be found along has been laid.

The attention to the use of the street as a dumpi other articles too numerous to mention is asked.

MILLBURY.

For the immediate protection of the citizens of arranged to have pathological examination made town, from cultures from the throat when diphth tubes and swabs can be found at the drug stores of will be furnished free by the State Board on applic Worcester board of health.

Newton.

The board complied with the order of the Cattle Commissioners and instructed the police to seize all unmuzzled dogs, confine them at the nearest station and report to headquarters. A man was then employed to visit the stations daily and take the captured animals to the pound, which was established at the city farm. One hundred and thirty-six dogs were captured by this method during the period of ninety days, of which seven were shot and the remainder returned to their owners upon compliance with the order of the Commissioners.

A new rule requiring live fowl to be restrained upon the premises of the owner or keeper was adopted by the board during the year, and will undoubtedly render our streets more sightly by removing all manner of live fowl from them. The keeping of swine in a rapidly growing suburban city is not favored by the board, and only under the most favorable circumstances will it be allowed.

The bacteriological examination of cultures from suspected throats as an aid to the diagnosis of diphtheria has been continued during the year and has been of great service to physicians. These examinations are made free of charge to the patients, and the practice will be continued during the coming year, but under slightly changed conditions. The type of the disease has been fully as severe during the past as during previous years; many very severe cases having been in the contagious wards of the Newton Hospital. Many of the deaths have occurred in cases where there was some delay in administering the antitoxin, owing to the fact that a physician was not called until the patient had been ill for two or three days. The board strongly urges the advisability of the early administration of antitoxin.

The board last year referred to the need of a detention ward, where suspected cases of disease, notably diphtheria and scarlet-fever, could be held under observation if necessary, and it again draws attention to this need. Such a ward would be very valuable in a case of suspected diphtheria, say, occurring in a domestic in a family where there are young children.

North Adams.

Two hundred and eighty-one official notices have been served. Ten cases have been prosecuted for not obeying orders of the board.

The Notch water-shed is very small, comprising only two farms and one or two "wood-lots." The slope on either side of the stream is steep, and the buildings dangerously near the water. As the city was building a large reservoir on this stream the board considered it advisable that it purchase the farms, remove all the buildings and allow the whole water-shed to grow up to timber. Acting on this belief it conferred with the State Board of Health, and its opinion being confirmed the matter was laid before the

mayor, and upon his recommendation the purcha made.

The board would call attention to the necessit tagious diseases.

North Attleborough.

We feel that there would be much less frictio maintaining good sanitary conditions throughout t seen fit to authorize a yearly examination of al public buildings, under the direction of the board.

There is one by-law of the town that is const people of the town, and especially in the busines refer to the strewing of paper, etc., around the str

During the past year the State Board of Heal examination of the discharges from the throats of affected with diphtheria; and also of the sputa o tuberculosis. We are unable to state how many and forwarded to Boston for bacteriological exami themselves of this privilege have failed to make a of these examinations was well illustrated in one that no evidence of diphtheria could be found. T showed his good judgment by isolating the famil case was removed by the report of the examinatio the throat. Thus, without further delay, the fa the hardships attendant upon quarantine.

The State provides antitoxin for the use of tow for such favor, that detailed records of the cases should be kept and forwarded to the State Board. has been used in the early stage of the disease t satisfactory. Out of twelve reported cases only In one of the fatal cases the child was not seen u bund; in the other case, death was due to par membrane having entirely disappeared.

Norwood.

Swine in the centres of population are regarded as a nuisance.

The sanitary arrangements of public buildings in people are housed should be in harmony with mode is never more true than in the matter of school-hou

The board of health, in the interest of commo every one to refrain from expectorating in any pu ance except into receptacles provided for the purp

Orange.

The amount of sickness has been far less than usual. Contagious and infectious diseases have been unknown; the death-rate has been 10 per cent. less than an average.

Quincy.

The general health of the city has been very good, no serious epidemic of contagious disease prevailing, nearly all the cases that have occurred being of a mild type, yielding readily to medical treatment. The danger from diphtheria, that dreaded disease, has now by the use of antitoxin been greatly lessened, and the death-rate lowered.

The board unanimously recommends that a more efficient service for the collection of the garbage of the city be maintained. By so doing it will be of great benefit to all, and the cleanliness and health of the city much improved.

Personal visits and inspections of all the public buildings, school-houses, etc., have been made by the members, and defects and nuisances been remedied.

Pittsfield.

One practice in our schools is without doubt a fruitful method of transmitting infection. We refer to the method of collecting pencils used by pupils during the day and passing them out indiscriminately the following day. We trust that the school authorities will order this practice permanently discontinued, as pernicious in its effects. When a pupil is reported as sick with scarlet-fever or diphtheria the books used by such pupil should at once be burned. It is to be regretted that one school building should be made the store-house for all the old books from all other schools in the city. These old books, as soon as unfit for use, should be destroyed at once. The general drinking cup should be a thing of the past, as it is a source of danger. Each child should have a cup of his own, as is the case in many schools.

Plymouth.

During the months of April and May an inspection of the town was made, and the contents of sixty-eight cesspools and privy vaults were ordered removed. A number of complaints have been made, all of which have been investigated. Eight houses have been connected with the sewer, by order of the board.

Provincetown.

Every year our town seems to be becoming more popular as a summer resort, and we ought to co-operate in making our shores not only clean, but just as attractive as possible. Let us place no obstruction in the way of the summer guest enjoying our shore privileges. We would recommend that measures be taken to do away with shore sewerage, also all promiscuous dumping of fish from wharves, etc.

Revere.

The work of connecting houses with the publi
ously kept up, and we trust that old-fashioned v
pools will soon cease to be a menace to the health o
desirable improvements have, of necessity, been
of rigid economy. Less complaint has been mad
geries than ever before. A sharp eye has been
very gratifying improvement in their general cond
donment of one large plant. The enforcement
plumbing is bringing about a sure change for th
the work done, and an added safeguard against
with slight exception, have cheerfully complied v
the board, and only in one instance has our auth
The inspection has been thorough, and accomplish

Salem.

The board has encouraged the use of antitoxin
the policy of furnishing it whenever there was c
would not be used. Practically, this resulted i
remedy by the board for nearly every case. It w
a correct record of the number of cases in which
complete reports could not be obtained from all pl
in a very large majority of the cases.

Sharon.

The favorable health conditions that have preva
the year have required but little service from the b

Somerville.

The number of loads of ashes collected during th
The house offal has been collected by the city d
same system that has been employed in the remova
The collection of night-soil during the year has
old-fashioned privy-vaults have been almost entire

Springfield.

The health of the city has been, on the whole,
serious epidemic of communicable diseases. Typ
46 times, chiefly in May and August. In the latt
cases were discovered in ward 5 and the adjacen
seemed to have a common origin. The patien
supply from a farm in a neighboring town. We

young woman had lived during a portion of the month of May; that she had become ill and left the farm about May 23, and at the time of this investigation was suffering from typhoid fever. The use of this milk was forbidden until it was evident that there was no reason to fear further contamination and the epidemic ceased.

The use of the diphtheria antitoxin, which was unusual at the beginning of the year, is now common and results in saving many lives. Forty-five cases received this treatment and 5 of them died, while of the 48 cases treated in other ways, 21 died. But in 3 of the 5 fatal cases the antitoxin was used when the patient was already near death, so that in those cases where the antitoxin was properly used only $4\frac{4}{10}$ per cent. died, while 47 per cent. of the others perished. That is, cases treated by antitoxin did ten times as well as cases not so treated.

Taunton.

No alarming epidemic has occurred, although the three important contagious diseases, diphtheria, scarlet-fever and measles, have been present in the city to some extent almost continuously throughout the year.

Diphtheria was decidedly less than the previous year, and at no time was the disease especially confined to one locality to any marked degree. The board has continued to distribute antitoxin gratis to the physicians, which has been, as also during the previous year, furnished to us at no expense by the State Board of Health. In November the board took advantage of the offer of the State Board to make free cultures for the Klebs-Loeffler bacillus of diphtheria. Stations where the culture tubes may be obtained have been established. This offer of the State Board in regard to antitoxin and culture examination applies equally to the adjacent small towns for which our board is headquarters.

The number of nuisances reported at this office and entered in the nuisance record book for the year has been 227, an increase of 30 over the preceding year. The majority of the complaints have been for overflowing or foul privy vaults, sink drains, cesspools, garbage heaps and foul catch-basins. The routine pursued by the board in cases of nuisances has been for the agent to visit the premises where the alleged nuisance exists; if the nuisance is real the proper person is notified verbally or by written notice to abate the nuisance within a reasonable time specified. If at the end of that time no steps have been taken towards abatement, legal notice is served upon the party, requiring him to abate the nuisance under penalty of the law. A continued negligence to abate is followed by a complaint lodged with the police department summoning the person into court. The greatest nuisance of all, and one over which the board appears to be powerless, is Mill River. During the summer months the complaints from this source were constant and unceasing. This vast sink-drain, receiving

the contents of numerous privies, sinks, cesspools
tainers of filth, during the hot weather is a source
ance to the unfortunate residents along its banks,
be confessed add their little or large share, as it
undue amount of foul deposit in the stream.

Tewksbury.

A child, aged three years and seven months, v
theria, being the first to show the disease, and hac
quiring intubation, the tube remaining in the laryn
a full recovery. The remaining cases were subjec
soon as the disease appeared, and though they had
form, all made full and perfect recoveries, which I
to the antitoxin treatment used, and skilled nursin

Waltham.

It has been the policy of this board to maintain
admirably set forth by its predecessors in regard
city, realizing that eternal vigilance is the price o
that the application of the best and latest scienti
to the physical well-being of any community.

We have strenuously insisted, as far as possibl
all buildings with the sewer system, when such bui
of sewer pipes.

Diphtheria. — There were 75 cases, with 5 death
removed to the Waltham Hospital for isolation, an
sible, in every case where the proper quarantine r
carried out at the patient's home. To prevent
quarantine too soon for safety to others, the board
which requires that two negative bacteriological re
three days apart, before the restrictions of the qua

Ware.

Diphtheria antitoxin is in general use by physic
care of diphtheria cases. The results following
good, and families generally are now willing to hav

Warren.

Scarlet-fever has been so mild that parents, i
recognized it, or no attention has been given t
children have been allowed to mingle with the publ
One unrecognized case makes mischief, and to a

recognized cases have been the cause of the continued epidemic of this disease during the past three years.

The board of health has obtained from the State Board of Health the establishment of a station where all physicians can procure culture tubes, to be used where diphtheria is suspected, also diphtheria antitoxin for the treatment of this disease.

Fifty-six children were vaccinated, as a part of the work of the board, this year.

Watertown.

Rules governing the use of the bath-house were adopted, and the work has been conducted satisfactorily since that time, giving apparent satisfaction to the people.

A slaughter-house has been a source of annoyance and trouble to the boards of health for several years. The proprietor was given every reasonable opportunity to keep his place in a presentable condition, and to obey the provisions of the law as he knew them. It was only after repeated complaints of violation of the law that it became necessary to take the extreme measure which was resorted to. It is very unfortunate that a man should be deprived of earning a livelihood such as he selects for himself, but it is much more important that he should have no opportunity to spread contagion and disease among people by the slaughter of tuberculous animals, and the opportunity to put such food into the market.

Many complaints were made about the keeping of large numbers of swine within the town limits, although outside of the scope of the rule formerly established by the board of health. On May 29, 1896, the rule was changed so that now no swine can be kept in any part of the town without a license from the board of health. The result has been a gradual diminution in the number of swine kept in close proximity to rapidly growing localities outside of the former one-mile limit where licenses were not required.

It has been demonstrated by thousands of cases that the *early* administration of antitoxin will cure nearly every case of diphtheria. The point that the board wishes to emphasize is that it should be injected in the beginning of the disease, and that parents should hasten to report cases of sore throat to their physicians. The State Board of Health manufactures antitoxin in its own laboratories, and furnishes it free of cost to any physician. A supply of this remedy, obtained from the State Board, is always kept on hand by our board, and will be furnished to any physician who applies to the agent.

Many patients have been known to have the germ in the throat long after all other symptoms have disappeared. Such a person is still capable of spreading the disease, and should not be allowed to attend school until the culture is found to no longer contain the typical germ. Impressed

with the importance of this precaution, the board
with diphtheria should be considered recovered un
found. The State Board of Health makes these
furnishes the proper boxes for taking the culture.

Westfield.

We make a much more favorable report of the g
of the town than in our last. Our mortality recor
and the decrease in cases of contagious and infe
couraging.

We believe the town is beginning to reap a ric
expended in her grand water supply, extending t
drainage, collection and removal of garbage by ou
thorough improvements which are being made.

Copies of the act of 1896, chapter 418, have be
bakeries, as required by the act, and a complian
insisted upon, as far as could be done, in the
The improvements are quite satisfactory.

Whitman.

The past year has been prolific of work in the
plained of, and sanitary irregularities to remedy.
complaints reported and attended to, against
Thirty-nine quarantine cards posted, against thirty

Winchester.

It having been brought to our notice that owner
where the public sewer had been completed, were
of the privilege of making house connections w
issued to property owners on those streets in whi
1894 the following notice : —

You are hereby notified that the public sewer on t
estate abuts is completed, and that your buildings sho
sewer, by a good and sufficient drain, immediately.

Connection will be made for you at a price not exce
material, by the sewer commissioners, on application f

You are respectfully requested to file your applicati

To this notice or circular was attached a copy o
laws of 1890, entitled "An Act to provide for c
public sewers."

Contagious diseases have been largely in exces
theria, particularly, has given us much trouble an

think, to the fact that parents, when there is a case of diphtheria in the family, will not strictly confine their other children to their own premises.

We have had quite a run of malarial fever, and the laying of our new sewer is, by many, thought to be the cause. This, however, cannot be the fact. There is no reason why the digging up of our streets, when the soil is mostly sand, should generate or liberate malarial germs.

Woburn.

With the advent of the sewers there is a decided improvement in the drainage of the city.

The number of cases of diphtheria for the past year was eighty-six, two of which were fatal.

During the year the board undertook and carried out the work of cleaning out Horn Pond, a large pond of about one hundred acres, into which the drainage of tanneries had been discharged for many years, and which had become offensive in consequence of the growth of large quantities of foul-smelling algæ.

Worcester.

Public baths have been repeatedly recommended in our annual reports, and it is a matter of gratification to this department that the establishment of the same is apparently near realization. Regatta Point, if it can be procured, is probably the best spot for location, but if it cannot be had there should be no difficulty in obtaining permission from the parks commission to locate on a part of the Lake Park.

Bacteriological Department.—The work of this department during the year has been satisfactory, and continues to justify its establishment. In several cases where death has been sudden, and suspicions of diphtheria aroused, we have been able, through its aid, by cultures made after death, to fix the disease positively, and thus fortified have taken the necessary precautions to prevent its further spread. Nine hundred and forty-seven cultures in all were examined during the year.

All the known bakeries of the city have been inspected and a copy of the act posted in each. Orders have been issued to make the alterations found necessary.

In August last a report was received of three cases upon the route of a milkman who lived in a neighboring town, and a visit was paid to his house, where he was found sick in bed suffering with what was said to be "malarial fever." A call by telephone the next morning upon the physician in attendance disclosed the fact that it was typhoid. It was also found that there was a case of it in the family of the man from whom the milk peddler received more than half his whole supply. He kept no cows himself, buying all of the milk from neighboring farmers. Prompt measures were taken to prevent any further spread of the disease from this source. In all, eight cases were reported, with two deaths, among families

who received their milk from this peddler. All c
beginning about the same time. No new case
symptoms began subsequent to the precautions tal
as was mentioned above.

The Isolation Hospital, for the treatment of
diphtheria and scarlet-fever, was completed dur
opened for the reception of patients Novembe
separate pavilion plan was the one selected by th
consists of four separate buildings, arranged some
hollow square.

The following rules have been adopted by the b
of the hospital: —

1. Patients may be admitted to the privileges of the
health, at such rates of board as it may from time to tin

2. In all cases where, in the opinion of the board,
patient will warrant it, the whole or a part of the board

3. Patients admitted to the Isolation Hospital cannot
unless such patients are dangerously ill.

4. Inquiries concerning such patients may be made
of health, or by telephone at the hospital.

5. If a patient should become dangerously ill, the
will be notified, with an intimation that he may be visite
cases only one visitor will be allowed.

6. Visitors are advised: —

   a. Not to enter any of the wards when in a we
      exhausted condition.

   b. To partake of food before entering the hosp

   c. To avoid touching the patient or exposing th
      to the emanations from his skin.

   d. To sit on a chair at the bed-side at some
      patient, and not to handle the bed-clothes

7. Visitors will be required to wear a gown, which
hospital, to cover their dress when in the wards, and to
with a disinfecting solution.

8. Each visit must be limited in time, and friends m
by the resident physician or the nurse in charge.

9. No visitor shall be allowed to give any article of
unless by permission of the nurse.

10. No visitor will be allowed to take any meal in t
night therein, without permission from the board o
physician.

11. When the patient ceases to be dangerously ill fri

12. Religious services for the dead may be held in the
is strictly limited to the officiating clergyman and th
immediate family.

13. Visitors are strongly urged not to enter any st
conveyance immediately after leaving the hospital.

NOTE.

The following information should have been inserted on page 682, at the close of the two years' summary of the use of antitoxin, but was received too late for insertion at that point: —

Use of Antitoxin for Immunisation.

Antitoxin, furnished by the State Board of Health, was employed at the Children's Hospital, for the purpose of immunisation, as follows: —

During the year ending March 31, 1896, in	678 patients
During the year ending March 31, 1897, in	511 patients
Total, ...	1,189 patients

No record was kept with reference to complications or sequelæ in these cases, but a note from the superintendent states that "urticaria occurred in only a small number of cases and these were not particularly noteworthy."

In three cases only did diphtheria develop after injection of antitoxin for immunisation, in one case in 36 days and in two cases in 23 days.

There was occasionally "some tenderness for twenty-four hours at the seat of injection, but it soon passed off."

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